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VOL. 72. NO. 2

A. PRESCOTT FOLWELL, Editor

TIMEWASTERS

We have another from W. M. Lee this month.

The Economical Wife:

A lady took a check (her husband's) to the bank and got it cashed. In error, the cashier transposed the dollars and cents. She spent 59 cents for some nose powder and then discovered she had twice as much money left as the check originally called for. What amount should have been paid her?

W. M. L.

That Literal Arithmetic Problem:

A Timewaster addict asks for help in solving our January literal arithmetic problem; it looks like nonsense to him—perhaps to others also. So we will go through the steps of the solution. Put the problem on coordinate paper so that each letter occupies a square, and call the top line 1, the second 2, etc.; and the left hand column *a*, the next *b*, etc. (1*a* is U, 7i is B, etc.). Then:

From line 3, col. g—K=zero.

From line 6— P=1.

From line 4 col. h—W x B give number ending in P; therefore W=3 or 7 and B=3 or 7.

But from line 4—B cannot be 7 (since 7 times the divisor would have four figures) and therefore is 3, and W is 7; also C is 6, U is 2 and 0 is 8.

From line 2—Since W is 7, I must be 5 and L=4.

From col. j—R=W+U=9.

Arranging the letters in order we have the words "public work."

Reginald H. Thayer reaches the same conclusion but using different letter combinations (several of these are possible) in his explicit demonstration. He also, combining arithmetic and ingenuity, solves the "unlucky 13" problem thus: $3 \times 3 = 9$; place the third 3 before the 9 and divide by the fourth 3. The snow shoveling profits, he finds, were $1.04 for Andy, 56 cts. for Bill and 32 cts. for Carl; easily determined, he says, by working the process backward from the finish. Or it can be solved algebraically, using three unknown quantities.

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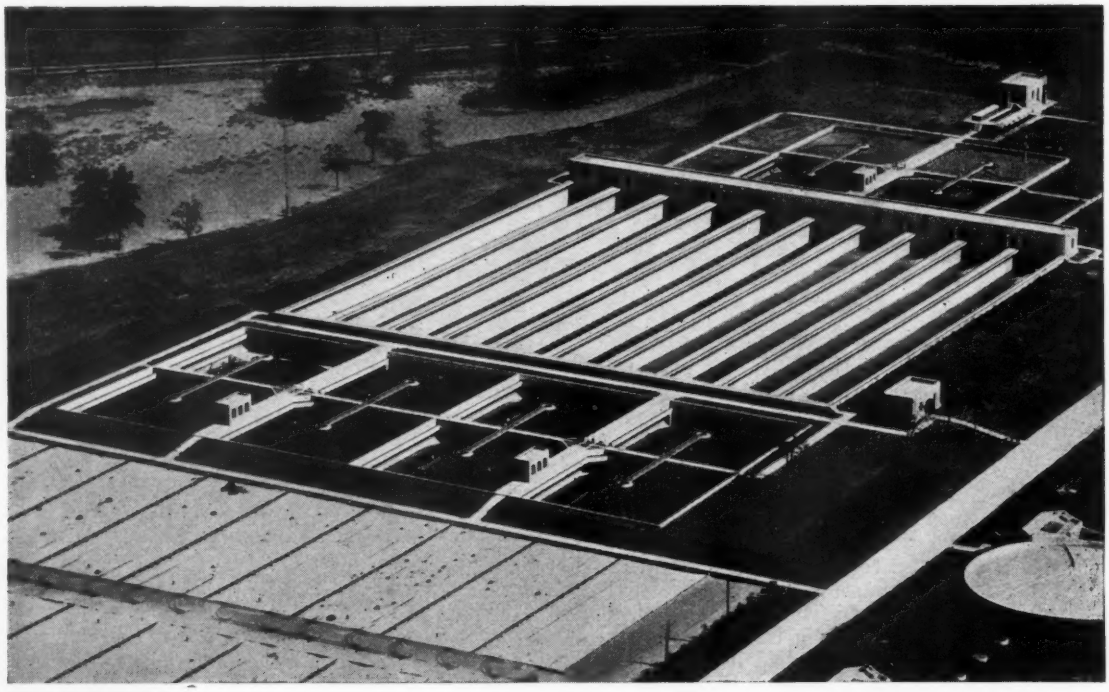
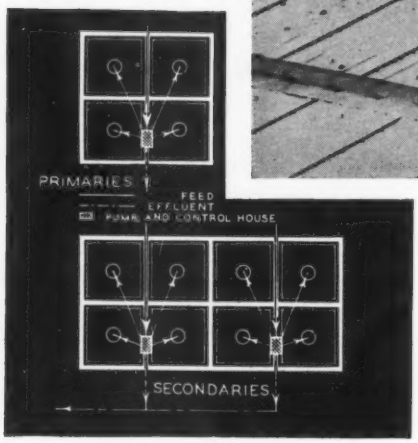
DORRCO SQUAREX CLARIFIERS

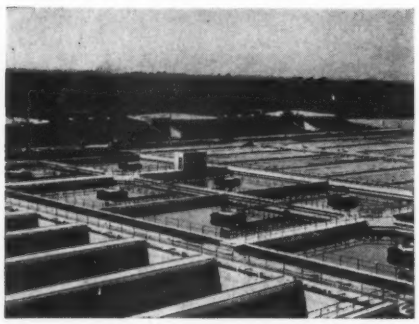


Gary, Indiana—8 secondary Dorrco Squarex Clarifiers in foreground; 4 primaries in background.



Flow arrangements at Gary

Close up of 8 secondaries; 3 Dorr Multdigestion Systems in background.



for ECONOMICAL TANK CONSTRUCTION

These photos of the Gary, Indiana, sewage treatment plant, illustrate how well Dorrco Squarex Clarifiers are adapted to inexpensive, yet attractive, sedimentation tanks with common wall construction.

For primary sedimentation ahead of activated sludge—four 75 ft. Squarex's, arranged in a square with 4 common dividing walls. For secondary sedimentation—eight Squarex's of the same size, grouped in a rectangle with 10 common walls.

Square tank construction, obtainable only with Squarex's is made possible by a mechanically operated blade that sweeps the corner area, beyond the reach of the normal blades. This blade action is positive and every square foot of tank bottom is swept at each revolution of the mechanism.

Common wall construction means less tank cost per unit of area. Square tanks mean, also, a compact, symmetrical arrangement plus a minimum of interconnecting pipe lines and channels.

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When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 55, 56 and 57

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VOL. 72. NO. 2

Sewage Treatment Plants for National Defense Projects

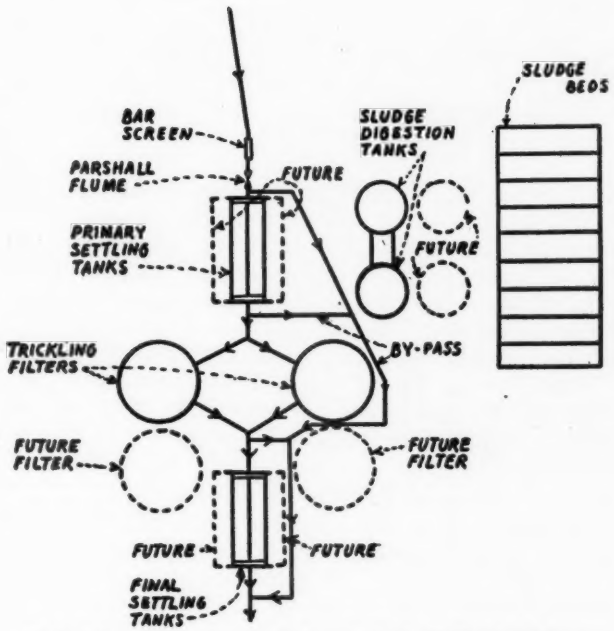
This is a general report on sewage treatment plants prepared by Metcalf & Eddy and Greeley & Hansen and issued by the Engineering Branch, Construction Division, Office of the Quartermaster General. It is slightly condensed for publication here; a list of sewage treatment plants as installed in the major cantonments is appended.

IN OCTOBER, 1940, Metcalf & Eddy and Greeley & Hansen were authorized by the War Department to render engineering services and make reports on sewage treatment problems at 39 National Defense projects. The projects for the most part are camps established for the purpose of training troops. The sites of these camps are scattered throughout the entire United States, though most of them are in the Southern areas. The personnel to be provided for varies from 1,500 to 66,000 men, with the majority having 20,000 to 30,000.

Sewage Quantities

The average quantity of sewage at camps and cantonments is estimated by the Construction Division of the Quartermaster Corps to be 70 gallons per capita per 24 hours. This, in our opinion, is a reasonable quantity of sewage, perhaps high rather than low. Although most of the 70 gallons may be discharged during 16 hours, all rates are expressed on the 24-hour basis. The fact that most of the sewage flow may occur within 16 hours has been taken into consideration in the establishment of liberal detention periods based on the 24-hour average flow.

It is known that there will be sharp variations in the rate of flow. The experience at the Army cantonments in the War of 1917-1918 is shown on Figure I. We recommend that sewage treatment projects be designed to provide for a maximum quantity of sewage, lasting for several hours, of twice the average quantity, or at the rate of 140 g.c.d. Hydraulics of treatment plants and other affected parts of the design should provide for maximum quantities, lasting for an hour or less of 2.5 to 3.0 times the average, depending upon the size and arrangement of the camp and the steepness of the sewers.



Typical layout of sewage treatment plant, National Defense Project.

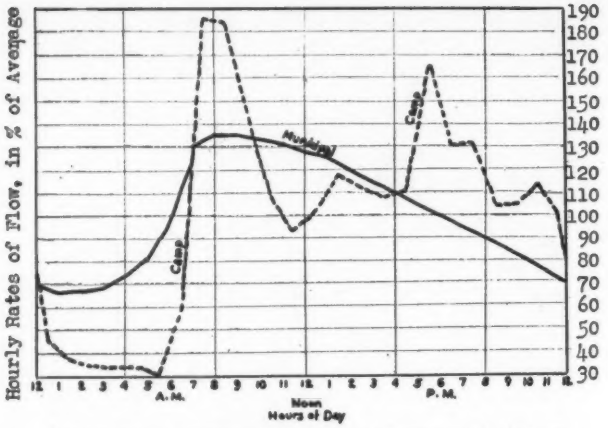
Sewage Characteristics

There is little information regarding the characteristics of sewage from Army camps because very few complete analyses were made of the sewage from the cantonments during the War of 1917-1918. A study of the few published records of sewage analyses from the cantonments in 1917-1918 indicates the following characteristics:

Item	*P.P.M.*	*Pounds per Capita per 24 hours*
Suspended solids	460	0.27
B.O.D. (5-day)	290	0.17
Ether-soluble matter ..	150	0.09

The per capita quantity of suspended solids is higher than is normally found in domestic sewage. This may be accounted for by the adult and male character of the personnel and by the relatively large amount of grease. The freshness of the sewage and the lack of opportunity for comminution of the solids may be another factor. While the unit quantity of suspended solids is relatively high, it is not considered too high for use as a basis of design, and is recommended.

The per capita quantity of B.O.D. is about the same as that in average domestic sewage but is somewhat higher than often found in residential sewage. It is considered to be a good estimate.



Comparison of average daily flow at camps with that of municipalities.

The per capita quantity of grease is two to three times that normally found in domestic sewage. The quantity of grease will probably vary considerably at the different projects, but experience with the older camps and elsewhere indicates clearly that the quantity of grease will be large.

The sewage will, in general, be very fresh and should have good settling qualities and the settled sewage should be readily amenable to treatment by biological processes.

Bases of Design or Plant Loadings

A summary of recommended bases of design for the sewage treatment plants is given below. These bases of design are considered desirable, but some departures from them have been approved to expedite construction.

1. SEWAGE QUANTITIES, G.C.D.
   - Average 70
   - Maximum—for several hours 140
   - Peak 210
2. SEWAGE CHARACTERISTICS, P.P.M.
   - Suspended solids 460
   - B.O.D. 290
   - Ether soluble 150
   - Per capita per 24 hours
     - Suspended solids ..... 0.27 lb.
     - B.O.D. ..... 0.17 lb.
3. MEASURING DEVICES
   - Parshall flume.
   - Rectangular flume, Palmer-Bowlus.
   - Venturi meter, if it fits force main on pumping station discharge.
   - Weir.
   - In general, have measuring device.
4. GRIT CHAMBERS
   - Omit except in special circumstances.
   - Hand cleaned, in general, with disposal by burying.
5. BAR SCREENS
   - Hand cleaned or mechanically cleaned as local conditions indicate. Screenings disposed of by burial or by burning in a suitable incinerator. Comminutors or screenings grinders under some circumstances such as proximity to occupied buildings.
   - Clear space of bar screen, 1" to 1"½.
6. PRIMARY SEDIMENTATION TANKS *Hours*
   - Displacement period based on average flow. Sedimentation only or ahead of trickling filters. In case of high dilution of settled sewage 2.5 hrs. may be used 3.0
   - Ahead of activated sludge based on average flow 1.5
   - Ahead of bio-filters, based on average flow:
     - (a) For a dilution ratio of 1:1.5 generally with single stage filtration 7.5
     - (b) For a dilution ratio of 1:1 generally with two stage filtration 6.0
7. TRICKLING FILTERS
   - (a) Standard, or low-rate, trickling filters in southern locations with no severe winter, such as the Gulf Coast states and Southern California—not to exceed 5,000 population per acre-foot. With filters 6 feet deep, this is 2.1 M.G.A.D. average at 70 g.c.d. In northern climates loadings should not exceed 4,000 population per acre foot.
   - (b) High-rate trickling filters to have loads not in excess of some 3,000 pounds of B.O.D. applied per acre-foot, for camps in the south. This is equivalent to a population of 35,000 per acre-foot. In northern camps the loading should not exceed 30,000 per acre-foot.
     (These loadings are somewhat high because of favorable conditions and desire for economy and speed.)
8. FINAL SEDIMENTATION TANKS
   - Flow not to exceed 800 gal. per sq. ft. per 24 hours, and not less than 2.25 hours' displacement, both based on the average flow, except when following two-stage bio-filters with recirculation ratio of 1:1 from the secondary tank effluent to the influent of the second-stage filter, in which case the capacity of the secondary tanks should be doubled.
   - Depth 10-12 feet with some reduction, or increase, in the depth in special cases.
9. SLUDGE DIGESTION TANKS
   - For plants of the trickling filter type for primary and secondary sedimentation and with heated sludge tanks 2.0 to 3.0 cu. ft. per cap.
   - For unheated sludge tanks in warm climates, add 25% to 50% to the foregoing, using the larger capacities in locations close to occupied buildings.
   - For plants of the activated sludge type, increase the foregoing allowances by 50%.
10. SLUDGE DRYING BEDS, OR LAGOONS
    - In warm climates and where the location permits, drying sludge in lagoons without underdrains or filter material is acceptable with 2.0 to 3.0 sq. ft. per capita.
    - Sludge drying beds with underdrains and filter material are also acceptable. For plants of the trickling filter type the area provided should be 0.5 to 1.0 sq. ft. per capita, and for plants of the activated sludge type this allowance should be increased to 1.0 to 1.5 sq. ft. per capita. The lower unit in each case applies to the most favorable conditions with opportunity for lagooning any excess sludge.
11. IMHOFF TANKS
    - Sedimentation compartment same as primary sedimentation tanks and digestion compartment same as for unheated separate sludge digestion tanks.
    - In northern climates, use for the sludge compartment of Imhoff Tanks: With plain sedimentation 2.0-2.5 cu. ft. per capita. With plain sedimentation and trickling filters 3.0-3.5 cu. ft. per capita.

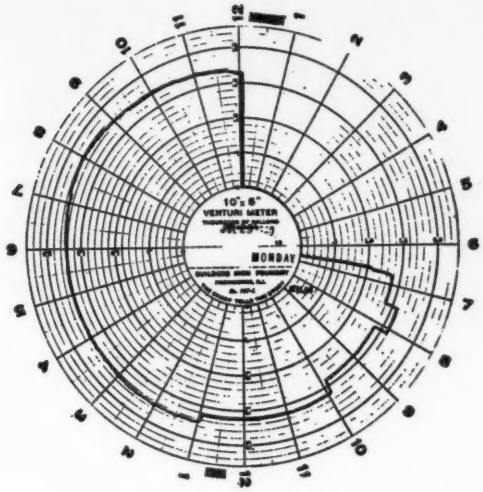
Indicated Costs

It is difficult to estimate the cost of sewage treatment plants for the projects because the haste and

(Continued on page 39)

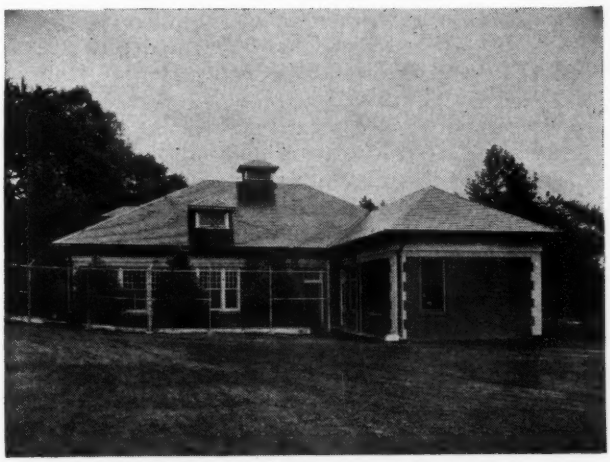
Manhasset-Lakeville Water District Reduces Pumping Cost 75%

A modern pumping plant, Diesel driven, replacing an old motor driven plant, has so reduced pumping cost that new plant will soon pay for itself.



THE Manhasset-Lakeville Water District, on Long Island, New York, has an area of approximately 16 sq. mi., and serves water to about 4,000 consumers. Until the spring of 1940 pumping was done with a 1100 gpm deep well pump driven by a 200 hp motor, and a 110 hp Diesel-driven reciprocating pump fourteen years old as a stand-by. During the hurricane of a few years ago no current was obtainable for six hours, and during this time the old Diesel was operated and maintained uninterrupted service.

Increase in capacity became necessary with growing population and Sidney B. Bowne, engaged by the Commission as consulting engineer, recommended a 2,000 gpm centrifugal pump driven by a 275 hp. Diesel engine. The equipment, furnished by the Turbine Equipment Co. of New York City as general contractor, consists of a 6-cylinder, heavy-duty type Atlas-Imperial Diesel, rated at 275 hp at 300 rpm, connected through flexible coupling and Link-Belt speed-increasing gear to two single-stage De Laval centrifugal pumps in series, delivering against a total head of 391 ft. 2,000 gpm at 1800 rpm.



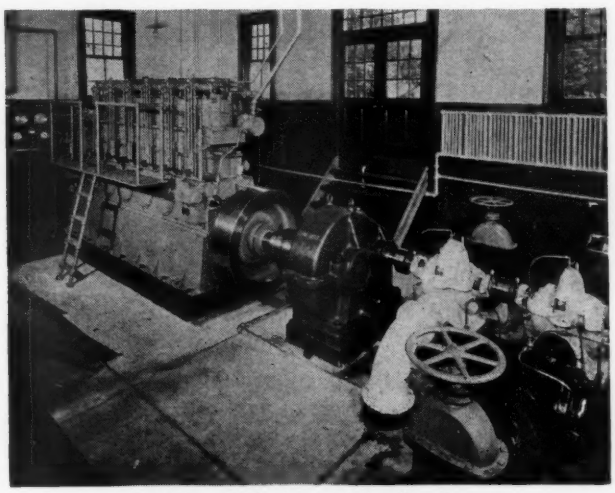
A neat little plant and a neat little profit.

Practically all engine auxiliaries are integrally mounted except the Alnor pyrometer, a starting air compressor and the Maxim exhaust silencer; and the new plant fits easily into the space previously occupied by the antiquated Diesel equipment. Jacket water is cooled by a Condenser Service & Engineering heat exchanger located in the discharge line from the pumps. Two Vortox air cleaners are installed on the intake manifold of the engine. Fuel and lubricating oil lines are fitted with Purolator filters. All elements of the new pumping unit are shaft-driven, even the vacuum pump being direct-connected to an extension of the second pump shaft. The engine cooling water circulating pump drives directly from an extension of the highspeed gear shaft on the side opposite from the first pump.

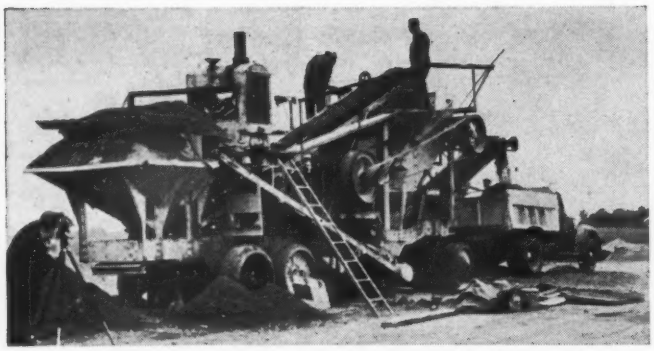
Six trial runs of the new plant made by Superintendent J. B. Reeves gave the following average figures:

Suction lift	18.39′
Discharge head	161.50 lbs.
Total head	169.20 lbs.
Delivery	2038 gpm
Engine load	248 bhp
Engine speed	297 rpm
Fuel consumption	0.394 lbs/bhp/hr

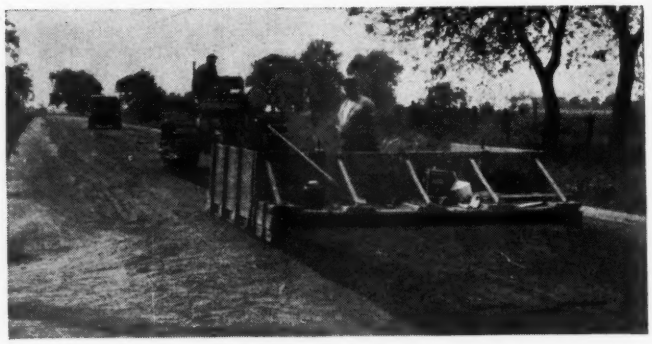
Therefore it required 110 gal. of fuel oil to pump 1,000,000 gal. of water. The cost for fuel and lubricating oil and a maintenance sinking fund at $1.00 per horsepower per year would be $8.16 per million gallons. Electric power at this plant cost $32.20 per million gallons, at the lowest power rate obtainable—1.54 cts. per kwh. At this saving of $24.04 per million gallons pumped, the new plant should soon pay for itself.



Interior of Manhasset-Lakeville plant.



Portable crushing and mixing plant at gravel pit for production of pre-mixed stabilized material.



Hauled to the road, plant mixed materials are dumped into a spreader box and evenly distributed over roadway.

Stabilization and Local Soil Aggregates

NATURAL surface soils are seldom suitable for wheel traffic in either dry or wet weather, not only because of dust and mud, but because they lack bearing power to carry modern traffic loads. But many such soils when properly combined with coarser or finer particles, usually obtainable locally, produce economically and quickly foundation courses that are stable in either dry or wet weather and are limited in bearing capacity only by their depth.

Among the special advantages of this type of surface are speed of construction, simplicity, and reduction in shipping in and hauling of aggregates. It is also possible to construct such a surface with very simple equipment; but except under those military conditions that require extreme haste, it is poor practice to use anything but adequate and modern equipment. Experience in highway construction has invariably shown that careful design and exacting and painstaking construction processes, utilizing equipment of a suitable type, are absolutely essential to obtaining a good finished product. Suitable drainage is necessary in this type of surface and must not be overlooked.

An advantage of this type of surface is the ability to utilize it during the stage-construction process, so that surfaces are available during all stages of camp construction. Roads can be laid out and drained and brought to grade and section by the use of motor graders and other equipment; and on this subgrade can be placed, as a surfacing, graded gravel. In some cases pit-run gravel can be used, but where it is possible to add necessary elements, as clay, top soil or sand, it will pay to do so. Such a surface when treated with the proper chemical will give excellent service during the construction period. Dust is eliminated, which is an important factor; loss of material is prevented so that the base does not decrease in thickness; the compaction under traffic increases the density and consequently the strength of this subbase; and maintenance is easy. Such surfaces, after use during the construction period, can be utilized as bases for higher type surfacings whether black-top or concrete, which are immediately available for traffic.

Maintenance requirements can be cared for, by the operation of a motor maintainer, whenever the weight and speed of traffic cause them. Where pot-holes develop, these can be repaired by filling with a stabilized mixture, prepared in advance by mixing in a small concrete mixer or even by hand. Such mixers give service far superior to that obtained by filling pot holes with gravel.

Most of the cantonments and many of the army air-fields are in the south where, as a rule, satisfactory material is readily available.

This same method of construction should prove of great value to the many communities that, because they are located within the sphere of influence of camps, air-fields or defense industries, will be faced with expansion. In Texas alone there are 35 camps, posts, air-fields and stations. All of the communities within reach of these 35 installations will undergo greater or less growth and will have to provide for some expansion of street, and possibly other facilities. Similarly, counties will be faced with road-building problems due to the same causes. Where there is some doubt as to the extent or duration of the demands to be met, stage construction may be a solution.

Directions for Dust Laying and Base Course

The Public Roads Administration some time ago issued a bulletin in which specific directions were given for dust laying and base-course stabilization, using calcium chloride. A portion of the information given is quoted below:

Use as a Dust Layer.—Calcium chloride for dust laying purposes must be applied periodically. The first application usually consists of about 1½ to 2 pounds per square yard of road surface treated. Subsequent treatments consisting of about ¾ to 1 pound per square yard are applied whenever the road begins to get dusty. The period over which an application remains effective depends on climatic conditions, the amount of traffic and the type of soil treated. Three applications from spring to fall are customary.

The chloride is applied uniformly over the road surface either by hand shoveling or with an agricultural lime drill with a spreader board attachment or by some type of sand spreader. The best time to apply the chemical is either shortly after a rain when the road is damp or early in the morning when the relative humidity of the atmosphere is high.

Rear view of traveling mixing machine showing the course of stabilized mixture.

Stabilization of local soil.

for Airports and National Defense Projects

Use in Road Surface and Base Course Stabilization.—Proper grading of soil materials is an essential requirement in the stabilization procedures involving the use of calcium chloride. Specifications have been prepared by the Committee on Materials of the American Association of State Highway Officials for materials for stabilized surface courses and for materials for stabilized base courses.

Soil mixtures for base courses for bituminous surface treatments should have lower clay content than that required in stable surface courses. Compaction of such bases by traffic prior to the application of the surfacing is desirable. Treatment with calcium chloride is one way in which base mixtures lean in binder can be kept from dusting and raveling excessively under traffic during the compaction period.

Calcium chloride is usually added to stabilized soil mixtures in the amount of one-half pound per square yard per inch of thickness, with a maximum of two pounds per square yard. The calcium chloride may be mixed integrally or used as a surface application. Quite often a combination of both methods is used; a pound to a pound and one-half of calcium chloride is combined with the stabilized material during the mixing operations and the remainder of the application is spread on the surface after initial compaction has been completed.

There are three methods for obtaining the desired stabilized mixture: plant mixing, road mixing, and the so-called "cut-and-try" method.

In plant mixing, calcium chloride is generally added to the mixture at the plant with enough water to bring the moisture content to about 8 to 10 per cent of the weight of dry soil. The mixture is hauled to the road, spread, sprinkled, shaped and rolled. In road mixing, calcium chloride is applied in the following manner: After the soil materials have been spread on the prepared base to the required thickness, the flake calcium chloride is distributed by spreaders capable of spreading the chemical uniformly and in the desired quantities. The calcium chloride is then thoroughly worked into the soil by harrowing and blading or by a traveling mixing plant until the surfacing material is uniform throughout. Sprinkling, shaping and compacting operations are then performed to produce a smooth, dense surface.

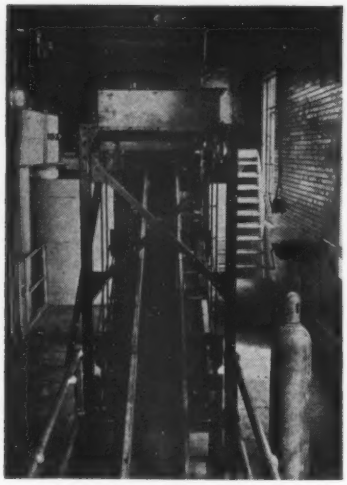
In construction using the cut-and-try method, calcium chloride may be applied to the road surface after its condition indicates that a proper gradation of materials has been obtained. The chemical may be applied by mechanical spreaders as on road mix jobs or it can be conveniently spread with a hand shovel.

Calcium chloride should not be applied during periods of cold, wet weather. The most favorable time for a surface application is during the drying period just following a rain after the surface has been bladed. The moisture in the road at that time hastens solution and penetration. In the absence of rain, application in the early hours of the day when the relative humidity is high is desirable. Calcium chloride applied just prior to a rain will probably be washed off the road and afford little or no benefit. When blading of the calcium chloride treated road is required, it should be done after rains or commenced near the end of a rain. At other times the surface may be too hard.

For patching holes, an admixture of 100 to 150 pounds of calcium chloride per cubic yard of graded soil is frequently used. Need for extensive patching during dry weather can be minimized or eliminated with light applications (½ to ¾ pound per square yard) of calcium chloride during the season.

A typical mud road prior to stabilization with calcium chloride.

Stabilized road, dustless, firm and capable of carrying moderately heavy traffic.



Sludge cake belt to sludge incinerator.

The Dewatering of Sludge By

BY LEROY W. VAN KLEECK,

Senior Sanitary Engineer, Connecticut State Department of Health

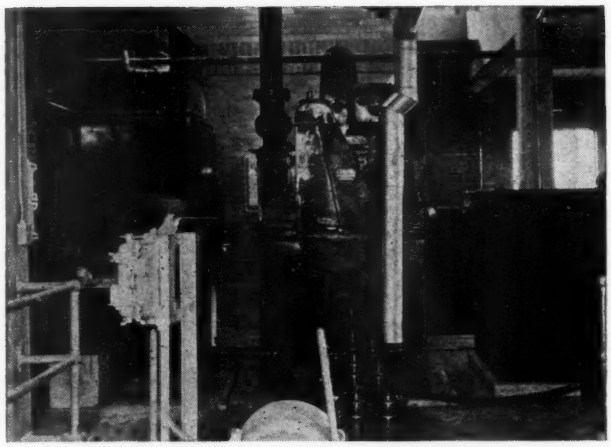
AN increasingly popular method of removing the excess moisture from sewage sludge is by means of vacuum filtration. The mechanics of filtration and some of the operating problems encountered serve as the subject matter for this paper.

Description of Filters

A vacuum filter is a rotating drum under internal vacuum mounted over a tank containing conditioned sludge, in which the drum is partially submerged. Conditioned sludge is raw, activated or digested sludge chemically treated for the purpose of gathering the sludge solids into larger flocs which will more readily release their water and prevent clogging (blinding) of the filter cloth. Ferric chloride alone or combined with lime is most frequently used for chemical conditioning.

As the filter drum rotates in the vat, the conditioned sludge is drawn on to the cloth, and a portion of the moisture in it is drawn through the cloth as it continues to rotate in the air. The water removed, called the filtrate, is generally returned to the raw sewage for resettling. Near the end of a complete revolution of the drum, the sludge blanket (now called the cake) is loosened from the drum by means of the blow-back and guided away by a metal scraper set close to the drum, or is lifted off by means of strings coming off at a tangent from the drum.

Whereas the conditioned sludge in the vat generally contains from 85 to 98 per cent moisture, the moisture in the sludge cake is usually reduced to between 60 and 75 per cent. Such dewatered material may be handled as a solid and compares in character to air-dried sludge as removed from sand drying beds.



East St. sewage plant, New Haven, showing sludge storage tanks in left background and sludge incinerator chimney.

The yield of filters is stated as the pounds of dry solids removed by the cloth per square foot of filtering area per hour of run. Yields of 2.5 to 8 lbs. per square foot per hour represent a common range, with usual yields of 4 to 6 lbs.

Only filter with an aluminum hood—New Haven, Conn.

Operation of Filters

In the operation of vacuum filters, vacuum pumps are necessary to create an internal vacuum and filtrate pumps are generally used for removing the water or filtrate inside the drum. Also air blowers are employed for supplying compressed air at the point of cake discharge, this air assisting in loosening the cake from the drum and keeping the cloth clean; but with string filters no air blow is used.

A vacuum of about 20 to 25 inches of mercury is maintained inside the filter drum. This vacuum is controlled by a lower and an upper filtrate valve, the lower valve controlling the vacuum in the sludge supply tank, the upper valve the vacuum during air drying. Occasionally with heavy sludge, the vacuum is reduced in order to secure a thinner or a wetter cake for burning in an incinerator. Sludge incinerators can be overheated by feeding sludge that is too dry or that contains too high a volatile solids content.

A complete revolution of the drum requires about 3½ to 4 minutes, of which the air drying cycle generally consumes from 2 to 3 minutes. The speed should be set for a cake thickness of about ¼ to ⅜ inches.

e By Vacuum Filtration

An engineer who has a wide acquaintance with vacuum filtration plants gives definite suggestions for operating them so as to obtain the best results, including conditioning, care of filter cloths, laboratory work, etc.

Disposal of Filter Cake

Cake from raw sludge should preferably be burned in a specially designed sludge incinerator. It can be used as fill but in such cases should be covered to control odors. The use of raw sludge cake as a soil conditioner is objectionable because of the danger of transmitting disease and the possible deleterious effects on the soil.*

Digested sludge cake may be suitably disposed of as fill, by burning, or as a soil conditioner. The iron content of digested sludges will not adversely affect most soils; the lime, if present, is of benefit to most soils; and soil bacteria will assimilate the grease present in such sludges.

Raw activated sludge when heat dried and ground makes an excellent fertilizer and should be disposed of as such at all but the smaller plants, in which the installation of the necessary equipment is not likely to prove economical.

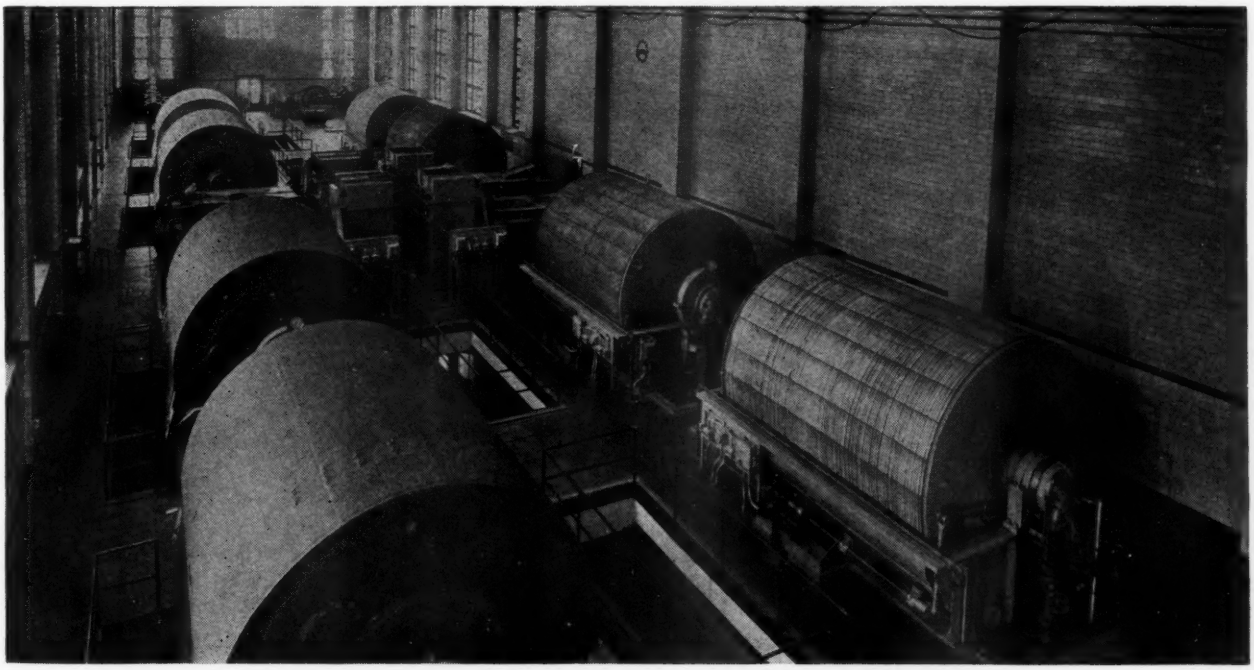
Record Keeping

Records for vacuum filter operation should include: (1) The gallons of sludge filtered. (2) The per cent of total dry solids in the sludge. (3) The per cent of volatile solids in the sludge. (4) The amounts of conditioning chemicals used, *reported in per cent on a dry basis*. (5) The pH, suspended solids, total solids and total alkalinity of the filtrate. (6) The hours of filtering. (7) The pounds of filter cake. (8) The per cent solids in the filter cake. (9) The filter yield.

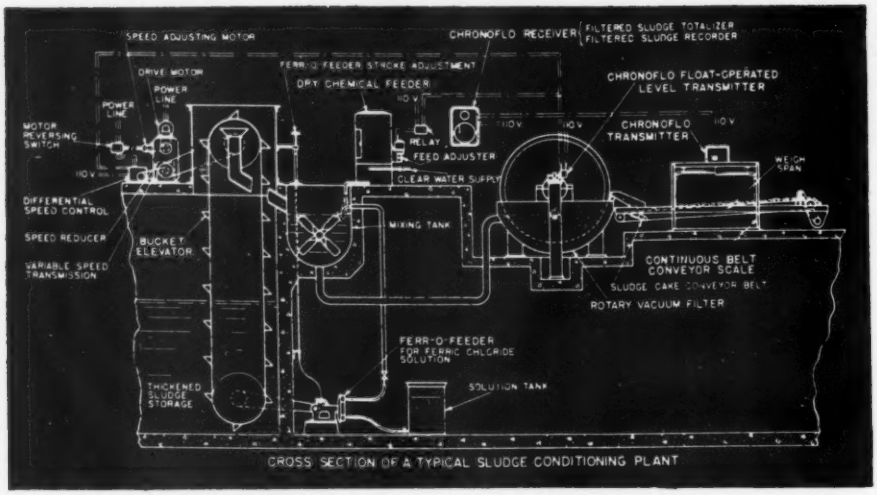
Control of Filtration

As with all phases of sewage treatment, a certain amount of laboratory work will make it possible to increase the efficiency, reduce the cost, and provide adequate records for sludge filtration. Briefly the more important tests are: (1) Solids determinations on the unconditioned and conditioned sludge, the filter cake and the filter filtrate. (2) Specific gravity and titration determinations of the strength of crystal and liquid ferric chloride. (3) Determinations of the color, turbidity, pH and total alkalinity of the filtrate. (4) The Buchner funnel filtration test on the conditioned sludge.

*For a discussion on the use of sewage sludge as a fertilizer see the author's article in Public Works for June, 1940.



11' 6" diameter by 14' long Conkey filter at Detroit sewage disposal plant.



Cross-section of typical sludge conditioning plant, showing "Chronoflo" automatic control for sludge conditioning, ferric chloride being fed by a "Ferr-O-Feeder."

Design Considerations in the Filtration of Primary Sludges

With some exceptions there are more advantages in the filtration of digested sludge than of raw sludge. Digestion tanks provide a place to store sludge during shut-downs, produce a more uniform product for filtration and burning, and yield a by-product gas which can be utilized for heating and power purposes about the plant. The odor accompanying digested sludge filtration is generally less and of a different character than that from raw sludge filtration. The filtration of digested sludge also permits a breathing spell in the filtering schedule; reduces the volume of sludge to be handled, thus making possible a reduction in filtering units; and yields a less offensive cake of a character more suitable for use as fill or as a soil conditioner. Also the chemical character of the filtrate from digested sludge filtration is superior, filter rates are generally higher and there is less trouble from cloth blinding.

In constructing new vacuum filter plants the designer should give particular attention to the following:

(1) Flexibility of the lay-out. Can the mixing time of sludge and chemicals be varied? Can the chemicals be added in a different order? Can each filter be served by a separate conditioning tank? (Separate conditioning tanks for each filter are not necessary in continuous filtration with a battery of filters, but are desirable with two or three filters with batch mixing or small continuous mix lay-outs). If an incinerator is provided, can the filter cake be by-passed to the outside for trucking away if desired?

(2) Provision of convenient sampling points for unconditioned sludge, conditioned sludge and filtrate. These are too commonly omitted.

(3) Provision of storage space for carload lots of chemicals to take advantage of favorable price quotations.

(4) If raw sludge is filtered, provision of at least one agitated sludge storage tank between the settling tanks and conditioning tanks.

(5) The conditioned sludge should feed by gravity to the filters.

(6) The filter vats should be drained by pipes at least 6 inches in diameter, which do not empty into the conditioning tanks.

(7) The filter feed pipes should be at least 6 inches in diameter, preferably 8 inches or more; should have full opening valves and discharge at two points beneath the sludge filter vat.

(8) The vacuum pumps should be protected from the entrance of filtrate.

(9) It should not be possible for the cake conveyor to spill sludge on the operating floor. Metal troughs built under the conveyors are generally desirable.

(10) A cake disintegrator is desirable. Several devices are available that cut the long strips of sludge cake into smaller pieces and aid in preventing hopper plug-ups, uneven incinerator feed and unbalanced weight readings when using automatic belt weighers.

(11) The filter appurtenances should be segregated from the main filtering room to reduce operating noise.

(12) The filter exhaust should discharge where its odor or noise will not prove objectionable. When sludge incinerators are provided, the base of the chimney makes an ideal point of discharge for this exhaust.

(13) There should be ample facilities for ventilating the filter room.

(14) The filter room floor should be pitched to a drain of adequate size for hosing.

(15) There should be no cross-connections between any potable water supply and the filtering or sludge equipment.

(16) How about safety? Has an elevated platform been provided to facilitate changing of the filter cloth? Is there adequate light? Are the filters crowded against walls or the ceiling so that wire feeding and other routine operations will be difficult? Are the conveyor belts and other moving machinery guarded?*

A modern vacuum filter plant, when properly designed, provides in a small operating space an efficient method of sludge dewatering. The waste liquor from it is easily handled, and the cake produced is amenable to disposal by burning, as fill or as a soil conditioner.

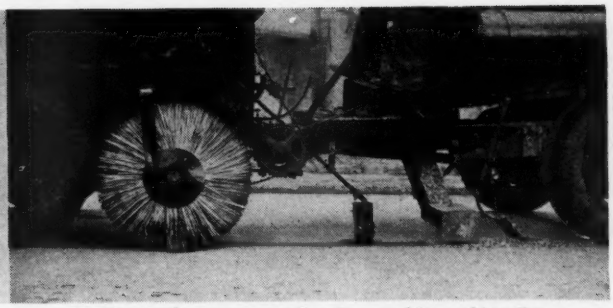
Major Factors Affecting Successful Filtration

The kind of filter cloth, its care, and the proper conditioning of the sludge are major considerations in sludge filtration.

(Continued on page 38)

*For a discussion of safety measures at sewage treatment plants see the author's articles in Public Works for August and October, 1938.

Marking machine for applying RC-3.



Marker and stone spreader for marking white line.

Center Line Marking on Indiana's Pavements

By N. F. SCHAFER
Engineer of Maintenance State Highway Commission of Indiana

CENTER lines have been developed because they add to traffic safety by defining traffic lanes. A pavement without a center line is more dangerous to travel since it does not tell the motorist what part of the surface is rightfully his.

A center line should be visible to both day and night traffic. A satisfactory center line must have not only the above characteristics, but in addition be reasonable in cost and have good lasting qualities. To be reasonable in cost the material which marks the line must be comparatively inexpensive and easily applied to the surface.

When the marking of center lines on our rural pavements was started some fifteen or more years ago, usually a white, yellow or other pigment paint was used. This was quite expensive, not only because of the relative high cost of the paint, but its life was short, requiring renewal every six months or at the most each year. In a search for more economical methods, cut-back asphalts were experimented with and found to be very satisfactory.

It was observed that RC-3 cutback gave excellent results as to durability. At first a covering of sand was used on the newly applied asphalt. The sand dulled the black color of the asphalt so that its contrast with the white concrete pavement was greatly reduced. Also, the sand did not produce a sufficiently white line to contrast well with a black bituminous pavement.

Making Either a Black or White Line

Late fall work showed that the RC-3 material could be applied during cool weather without any covering aggregate. This gave a jet black color that showed good contrast on the light colored concrete roads. This center mark of RC-3 also filled most of the center joint in the concrete pavement and this saved a repair expense on the joint filling. Furthermore, it made a much neater looking line than if the asphalt had been poured only as a joint filler.

A distinct white line on a black bituminous surface is made by using the RC-3 asphalt and covering it with a finely crushed white stone aggregate. While the amount of traffic and condition of the pavement controls somewhat the length of life of such markings, the white mark has been known to last as long as six years with satisfactory contrast.

In order to prevent the newly applied asphalt from cracking over the pavement, it is applied when the atmospheric temperature is below 50°F. It has been applied when the temperature was as low as 32°F. and satisfactory results secured. The pavement should be dry but not necessarily warm. If the work is done in warm weather it would be preferable to use an RC-4 grade of cutback instead of the RC-3 grade.

A special machine was developed for this work, consisting of the axles of an old Ford car cut down to about 3 feet length and a frame built upon these axles with about 24-foot wheel base. The machine is driven by an engine mounted on the chassis near the rear axle and is steered by the driver sitting just behind the engine. Mounted on the rear of the machine is a heating kettle from which the hot asphalt flows to the nozzle and shoe that applies the asphalt line just back of the rear axle. This narrow marking machine in the center of the road permits traffic to pass both ways with no more interference than possibly slowing down.

By the use of a pointer or guide suspended from a rod extending forward from the machine, the driver is able to guide the machine to follow the old center line or other guide mark on the pavement. This pointer dropping down some distance in front of the machine together with the long wheel base makes it possible to make a mark that is straight or uniformly curved to fit the pavement. A considerable variation of the indicator or front wheels from the proper position momentarily does not appreciably affect the side shift of the shoe at the rear axle.

While the first machines were home made, recently good commercial machines of a somewhat similar nature have been placed on the market.

If white aggregate is applied to the RC-3 material for making a white line on a black pavement, such aggregate is shoveled into a hopper at the rear of the "tender" truck which follows the marking machine. The aggregate feeds by gravity through a chute on to the asphalt mark just behind the marking machine. To this truck is attached a small roller which presses the covering aggregate into the asphalt. The cool tem-

Views showing black line and white line.

perature soon stiffens the asphalt so that it holds the aggregate in place.

Since comparatively low temperatures are desirable for making the mark by this method, the work has to be done during the spring and fall season. The method, however, permits the application of a great length of center line in a short time. Crews have applied as much as 20 miles of center line in one day.

The same machine is used to paint "No Passing Zone" lines. This is accomplished by closing the valve to the asphalt tank and opening the one to the paint tank. For this work two shoes are required so that the line may be painted on either or both sides of the center line at the same time.

The following are brief specifications for applying center line with cutback asphalt:

I—For black mark on light colored surfaces. Apply RC-3 (heated to 150° to 175°F.) when atmospheric temperature is 25°F. to 50°F. with no covering. Comparatively low temperature is necessary to prevent asphalt from being tracked and smeared by traffic. The asphalt gradually hardens on warm days and absorbs a certain amount of dirt and grit which prevents tracking when warm weather comes. It retains the black color.

The cost of the above line is from $4 to $6 per mile, including labor, material and equipment. Sometimes the repair cost saved from hand pouring the center line may be equal to this sum. Generally, re-marking is not required oftener than every other year.

II—For white mark on black colored surfaces. Apply RC-3 when atmospheric temperature is 35°F. to 55°F. covering immediately with ¼" size white crushed aggregate and roll. A comparatively light roller attached to the tender truck carrying the aggregate may be used. Here, as in I above, it is desirable to apply the cutback asphalt on a comparatively cool day so as to prevent tracking of the asphalt over the surface.

The cost of the above type of line is from $10 to $12 per mile, including material, labor and equipment. Such lines last from 3 to 6 years.

The above method of center line marking as used by the Indiana State Highway Commission is the result of many years of experience with all kinds of materials and methods. It seems to be a very satisfactory method and the cost is only a fractional part of other methods and materials used in other places. One of the conveniences and low cost features of the above method is that the same grade of cutback asphalt is used for making a white line as is used in making a black line.

Technical Editors Needed by War Dept.

In connection with its defense work the War Department is in need of technical editors to perform various writing duties, and prepare for publication technical manuscripts and reports. The work will be confined largely to the fields of engineering, chemistry and physics. The salaries of the positions are $2,600 a year for Assistant Technical Editor, and $3,200 a year for Associate Technical Editor. To fill the position the U. S. Civil Service Commission has announced an open competitive examination, and will accept applications not later than February 20 and February 24, 1941, the extra time being allowed for those sent from Colorado and states westward.

Applicants will not be given a written test, but will be rated on their education and experience and on corroborative evidence. They must have completed a 4-year college course with major study in engineering, physics, or chemistry, and in addition must have had experience in the writing or editing of technical material in one or more of these fields. Persons who have not completed the full 4-year college course may substitute appropriate professional experience for not more than 2 years of this requirement. Graduate study in scientific fields may be substituted for part of the writing experience.

Further information and application forms may be obtained from the Secretary of the Board of U. S. Civil Service Examiners at any first- or second-class post office, or from the U. S. Civil Service Commission, Washington, D. C.

Skilled mechanics also are wanted by the Cvil Service: Toolmakers, instrument makers, machinists, aircraft instrument mechanics, aircraft mechanics, metalsmiths (aviation), coppersmiths, lens grinders, loftsmen, ordnance men (torpedoes), shipfitters, and ironworkers (shipfitting duty).

Soda Water From the Service Pipe

"Frosty sodas" direct from the water tap caused a druggist at Virginia, Illinois, to frantically call B. Sallie, water superintendent, to his store. Upon investigation it was found that the CO_2 gas machine was leaking into the water supply line. "Bill" told them to repair the leak and put in a proper check valve. The next call was worse than the first for the entire tank of gas was gone in "short order." This check-up showed that the check valve was placed backwards in the line and allowed the CO_2 gas to go into the water main. No serious results occurred in either case except that it looked like clear sparkling "something or other."

The Editor's Page

Maintaining Public Utilities in Army Cantonments

There are now some fifty major army posts and camps in which our expanding army is being housed. The population in these ranges up to more than 60,000 men, in some cases. About half of these posts and stations—to use an army term—are new, the remainder being enlarged and expanded from regular army or National Guard posts. In all of them, there is a maintenance and operation problem in regard to highways, water and sewerage, and this problem is comparable to that of a good-sized city.

Some of these posts have 50 or 60 miles of roads, which will require intensive and continuous maintenance under the pounding of the heavy army traffic. A contributing factor is the haste with which these camps were built, so that proper drainage and subdrainage and good foundations were not always provided—it being more important to complete construction for housing troops than to remove the last small defect in construction. Many new sewage treatment and water purification plants have been built and many hundreds or thousands of miles of sewers and water mains have been laid. These utilities, too, will require operation and maintenance. And since these, too, were built in haste, more skill in plant operation and more maintenance of water and sewer lines will be required than in carefully built, going municipal plants.

The army authorities charged with the maintenance and operation of these utilities are aware of the problems they face and they are planning to install skilled personnel in these important positions. On the whole, the record of accomplishment so far, as regard the provision of modern roads, sewerage and sewage treatment and water supply and purification, has been excellent, and the recognition that skilled men are required for maintenance and operation is something many of our cities should heed.

Preventing Night Sabotage

A bomb thrown through the window of a pumping station or down a reservoir gate well or placed under an aqueduct can cause plenty of trouble; and sewage treatment plants are but little less vulnerable. So far there has been no sabotage of this kind in this country—munition plants are much more important targets. But protection against such acts should be included in our preparedness program. Guards at vulnerable points are the basis of precaution, but even an impracticable number of these cannot be effective on dark nights unless artificial illumination is provided. Springfield, Ill., has already planned to fence all its water, light and power properties and floodlight them; Milwaukee is installing lights around its water plant; Schenectady, N. Y. soon will have lights at its pumping station and reservoir.

Some pointers on how to make such lighting most effective have been suggested by A. F. Dickerson, manager of the General Electric Lighting Division, Schenectady. These are as follows:

1—Plan your protective lighting for the worse possible visibility conditions so it will be adequate when sabotage would most likely be attempted.

2—Make lighting of disadvantage to the saboteur. If there is glare, be sure it blinds the intruder, not the guards.

3—Do not create shadowed areas in an attempt to illuminate other areas.

4—Put more light around the boundary of a property or at distant points if the guards are located in well-lighted areas. (Light in the foreground reduces distant vision because of contrast.)

5—Keep all backgrounds as light as possible, paint fences and buildings in light colors.

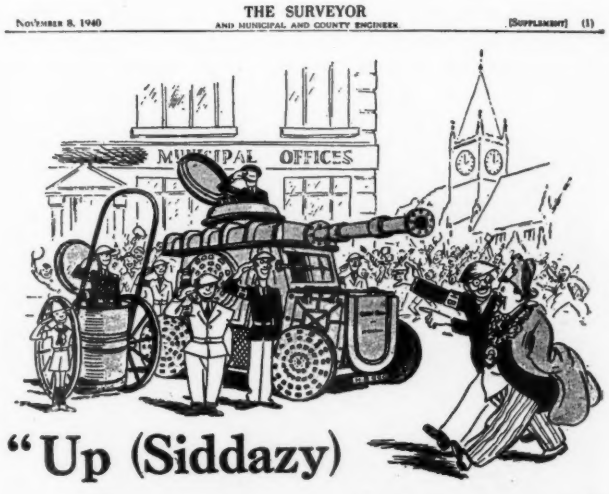
6—Plan area lighting so that some light is contributed to any one point from more than one source. Thus a lamp failure will not set up an unduly dark or shadowed area.

7—Direct light across highways, streets, railroads and navigable waterways so that glare or brightness will not prove a hazard to traffic.

8—Keep as much of the lighting equipment as possible well within the property to prevent attempts to put it out of operation.

Humor Still Survives in England

One interesting feature of the information that reaches us from England is the way the people generally manage to find a humorous side to the most serious occurrences. Ordinarily an advertisement in an engineering paper is the last place in which one would expect to find humor, but one English advertiser, at least—Ham Baker & Co., manufacturer of iron and steel products for public works—tries to bring a smile to the set lips of the engineers who read "The Surveyor," published in that "tight little island." One such effort is reproduced (much reduced) herewith, showing some of the advertiser's products—street sweeper's cart, manhole covers, iron pipe, tide gates, etc.



"Up (Siddazy) Guards and at 'em!"

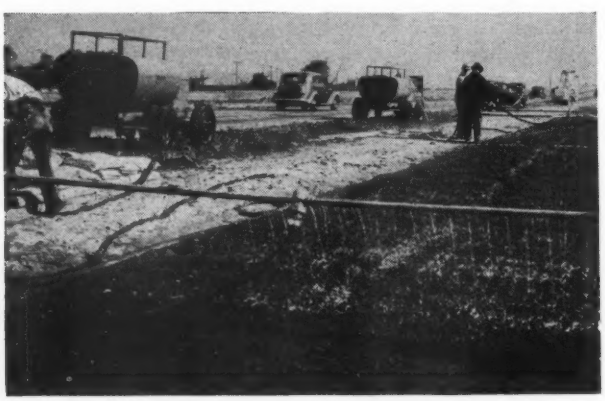
Rototiller mixing sand and cement.

Sheepsfoot roller tamping the mixture.

A Bicycle Pathway of Soil Cement Construction

AN INTERESTING feature of the new Belt Parkway, under construction in Brooklyn, N. Y., is a bicycle pathway twelve feet wide and extending, at present, from 65th Street, Brooklyn to Utopia Parkway, a distance of 13.76 miles. Tentative plans have been made to extend this path the full length of the Parkway, a total distance of twenty-six miles. Soil-cement construction is being used, different amounts of cement being used in different sections to test which gives the best results; the amounts averaging 10% to 10½% by volume.

The path is composed of hydraulic sand fill on a base of sand-gravel. Each morning, board forms are placed for a section averaging two hundred feet long, which is finished the same day. The fill is raked to an even surface with hand rakes, after which practically all the work is done by machines. Cement is spread over the sand fill and *"Rototillers"* are run for about two hours to work the sand and cement together, after which the section is wetted down by the use of twelve-foot sections of irrigation pipe attached by hose to water wagons and working under pressure. The Rototillers are again used to work over this mixture, after which sheepsfoot tamping rollers are used to compact it, small Type HG Cletracs being used to pull the 4200-pound tampers. Care had to be exercised so as not to break down the board forms or crack the three rows of brick which will line each side of the path. For this reason the types of machines used were found to be most adaptable to the requirements. (The Rototiller originated in Switzerland. A 6 hp motor is geared to the propelling wheels and to a gang of sharp-pointed, self-sharpening, spring-mounted tines that revolve through the soil like picks, breaking it up rather than cutting it as disks do. The model used on this job cut a bed 20″ wide 10″ deep.)



Wetting down the mixture by means of irrigation pipe.

After compacting, the path is screeded off with a 2 x 10 ft. scraper and then rolled with a flat roller. Any part of the surface requiring it is then hand troweled, and a final rolling with the flat roller completes the job.

After completion, refreshment buildings may be constructed at intervals along the length of the pathway for the convenience of pedestrians and bicyclists.

Strengthening and Widening Highway Bridges

In illustrating the article with this title which appeared in our January issue we showed, on page 10, "before" and "after" views of a bridge over the Allegheny River which had been widened and strengthened. The author calls our attention to the fact that the two pictures should be interchanged; that captioned "before widening" was really taken afterward and vice versa.

Reducing Unaccounted For Water

By CHARLES O. THOMAS

Superintendent, Water and Light Plant, Hope, Ark.

Charles O. Thomas.

HOPE, the county seat of Hempstead County, Arkansas, with a population of 7,477, has the distinction of having the largest increase (24.4%), in population of any city in Arkansas, as shown by the recent government census. Hope is on the Broadway of America and is the home of the world's largest watermelon.

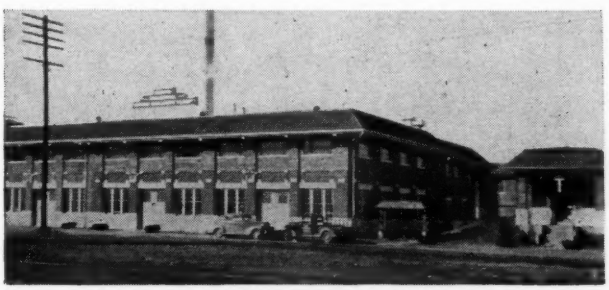
The city's water is obtained from three deep wells and is pumped directly into the mains without treatment. The quality of the water is very good for both domestic and industrial purposes. Bacteriological tests are made periodically by the State Board of Health as a precautionary measure. Ample reserve supply is contained in two concrete surface reservoirs. The direct pumping method is satisfactory and a surprisingly uniform pressure is maintained.

The writer was appointed superintendent of the plant in June, 1939, and among the problems he found was the one of an unusually large amount of unaccounted for water, over 40%. The following tells what has been done about it and the results obtained thus far.

Our plan of campaign was as follows:

1. To meter all free services.
2. To meter all plant services.
3. To find and stop all the distribution leaks possible.
4. To field-test all meters and replace all inaccurate ones.
5. To provide the means for accurate testing of meters found to be inaccurate by the field-test, and repair these meters if possible.
6. To meter all unmetered services.

The metering of all the free services and the plant services was simply a matter of buying the necessary meters and installing them. These accounted for an average of 9.4% of the water pumped or 6.6% more than had been customarily estimated for that purpose.



Front view of Hope water and light plant.

The finding and stopping of distribution leaks is a job that goes on all of the time. This is particularly important in Hope, because of the large amount of such leaks. We have here a "Gumbo" soil which, due to the shape and size of the particles and extremes of moisture content, combined with extremes of temperature, shrinks, swells and cracks to such an extent as to affect the foundations of well constructed buildings. The effect of this movement of the soil is most noticeable during the dry, hot summer months. It is the cause of many joint leaks and is even great enough at times to unbell a pipe joint and, by setting up uneven stresses in the pipe lines, has caused the breaking or splitting of the pipes.

It is practically impossible to do more than make a rough estimate of the amount of the distribution leaks that we have stopped. I estimate this as follows: Flush tanks and old services that had been allowed to run, 730,000 gallons a month; reductions in joint leaks, 170,000 gallons; a total per month of about 900,000 gallons. Even if only approximately correct, this amount is important as it represents 7½% of an average month's total pumping.

It was realized that to remove all the meters and bring them into the plant for testing, setting other meters to take place of the ones being tested, would be a slow and costly job. Many meters would be tested and found well within the accuracy requirements, and since our aim was to find the meters that were inaccurate and not the ones that were functioning properly, every meter tested and found accurate would be time and money wasted. To expedite the work and keep the costs within reasonable bounds by finding out which meters were inaccurate without removing them, we bought a portable test meter. To date we have tested all of our residence meters, some 1,216 in number, using the portable test meter. The crew on this work, consisting of two men, averaged 18.7 tests per eight-hour day, and at the rate paid them the cost per meter was 31 cents. The field testing of these 1,216 meters was made on two approximate flows, viz., 12 gallons and 2 gallons per minute.

When the work of testing with the portable test meter had been completed the results were tabulated opposite the customer's name. This table also showed the average monthly water bill of the customer. Some meters were found to be fast, these were replaced as soon as found. The fast meters were probably the result of improper repairs and the installing of improper change gears by some one in the past. If a

Number 3 well and concrete reservoir, Hope, Ark.

meter was found to be slow and the customer's average water bill was equal to or greater than the amount shown in Table I and the meter was slow by an amount equal to or greater than the percentage shown opposite the amount of the bill, the meter was brought in for further testing and repairs, using our volumetric test bench.

TABLE I

Average Monthly Bill	*% Meter Slow*
$1.00	4.20
1.40	3.00
1.80	2.20
2.20 or more	2.00

Table I is based on an average cost of repair per meter of $2.50 and an average life of six years without repairs.

Since the field testing was done through two orifices which allowed an estimated flow of 12 gallons and 2 gallons per minute, respectively, we assumed that, of the water a customer used, two-thirds of the volume would be at a rate of 2 gallons and one-third at a rate of 12 gallons per minute. In other words we assigned a weight of two-thirds to the 2-gallon and one-third to the 12-gallon per minute flows. Then, for example, having tested a meter and found it 6% slow on the 2-gallon and 3% slow on the 12-gallon per minute flow, with an average monthly bill of $1.00, we proceeded as follows:

6% of 100 gals. is 6 gals. 2/3 of 6 gals. = 4 gals.
3% of 100 gals. is 3 gals. 1/3 of 3 gals. = 1 gal.

Total is 5 gals.

Now 5 gallons is 5% of 100 gallons. Referring to Table I and opposite a $1.00 average water bill, it is seen that the meter is to be removed for repairs. It is realized that the above specifications are liberal and that the percentages are high, but we decided to use them for the first going over. Later, when this has been done and the full results determined, another and tighter specification can be drawn, if experience shows that it would be justfiable from an increased revenue standpoint.

At this time we are 84% metered. All services having sewer connections are metered and also a considerable number of our customers who are not connected to the sewers. So far we have not been able to increase greatly the per cent of metered services, as it has taken all of what we considered a reasonable expenditure for new meters to replace the meters we have found inaccurate and beyond repairing.

Until recently the water department had a very unsatisfactory method of testing water meters. It consisted of placing, on the line with a new meter, the meter that was to be tested. Water was allowed to run through both meters and if the old meter showed the same reading as the new one the old meter was considered correct. This method of course could not be satisfactorily used to test meters at various rates of flow, which is so important in the determining of the over-all accuracy of meters. This condition was corrected by purchasing a volumetric meter test bench having a capacity of two meters at a time and a range covering 5/8" through 2" meters. The bench is simple to operate and has already demonstrated its value to our satisfaction. One of the first meters we tested with it was the meter we had been using to test other meters with. We found this meter to be slow.

We are testing our meters on the test bench at the rates of 12, 2, 1 and 0.25 gallons per minute. Recently we have been dividing our repaired meters into two classes. Class 1 meters are those which pass A.W.W.A. specifications on the above mentioned rates of flow; and Class 2 meters are those which pass A.W.W.A. specifications on the first three flows but which fail on the 0.25 gpm. flow. These Class 2 meters are placed on small newly metered services.

An article of this nature to be of any value to others, should give specific information, so described that others can evaluate it in terms of their own conditions and apply it to their own problems. The following data refer to conditions in our plant as of June, 1939 and in late 1940.

Table 2—Comparative Data of June 1939 and Late 1940

	June 1939		*Late 1940*	
	Number	*%*	*Number*	*%*
Total number of services....	1,627	100	1,693	100
Total number of metered services	1,288	79	1,419	84
Total number of unmetered services	339	21	274	16
Gain in services.....	—	—	66	4
Gain in metered services....	—	—	131	10
Gallons pumped 12,240,000		100	11,680,000	100
Gallons sold through meters.. 6,637,000		54	7,681,000	66
Gallons sold at minimum rate	220,000*	2	256,000	2
Gallons given away.....	462,000*	4	807,000	7
Plant use	—	—	463,000	4
Gallons unaccounted for..... 4,922,100		40	2,483,000	21
Revenue per thousand gallons pumped	24.4c		28.9c	

*Estimated

The above data is self-explanatory, but it is to be

In Detroit... It's

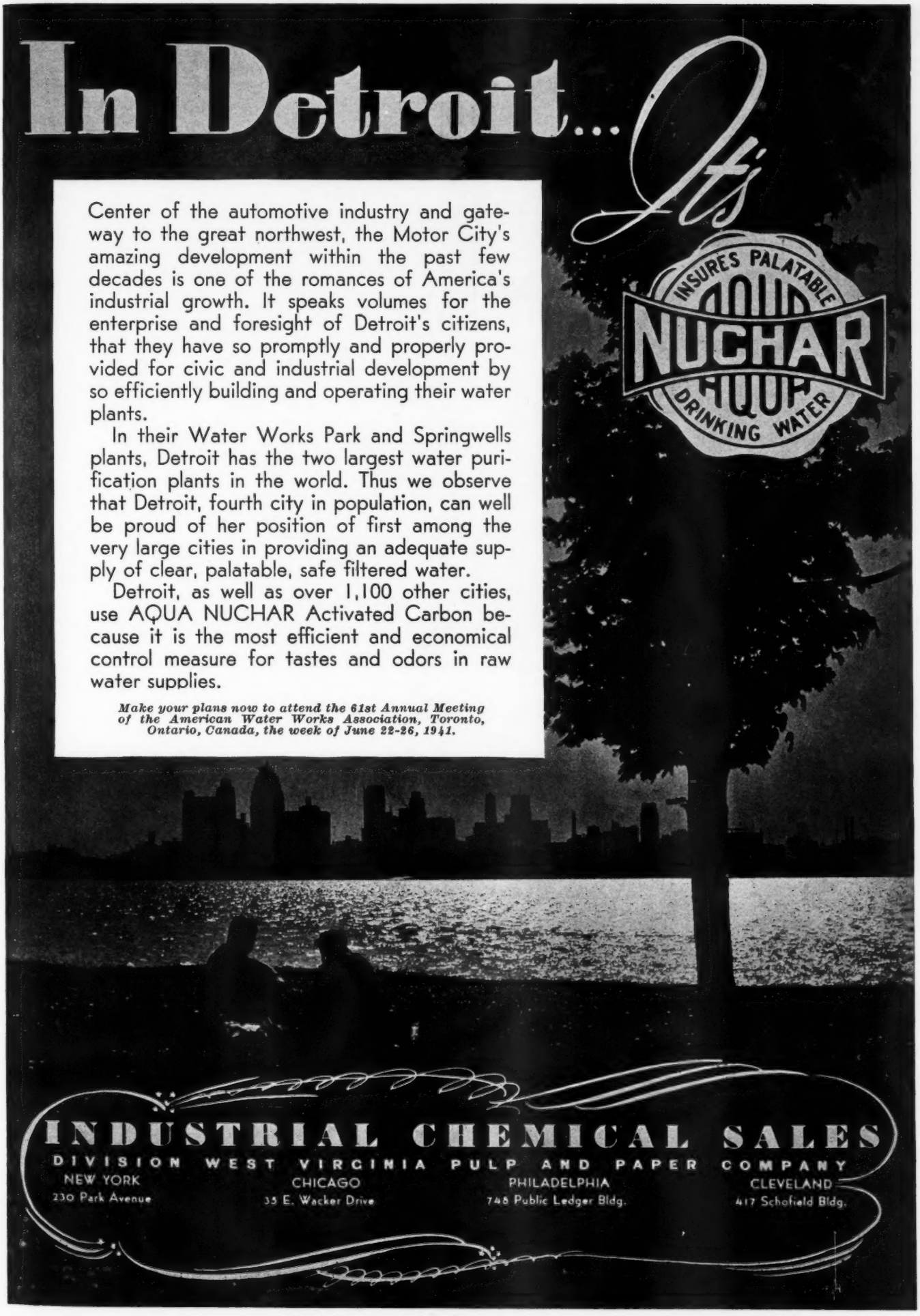
Center of the automotive industry and gateway to the great northwest, the Motor City's amazing development within the past few decades is one of the romances of America's industrial growth. It speaks volumes for the enterprise and foresight of Detroit's citizens, that they have so promptly and properly provided for civic and industrial development by so efficiently building and operating their water plants.

In their Water Works Park and Springwells plants, Detroit has the two largest water purification plants in the world. Thus we observe that Detroit, fourth city in population, can well be proud of her position of first among the very large cities in providing an adequate supply of clear, palatable, safe filtered water.

Detroit, as well as over 1,100 other cities, use AQUA NUCHAR Activated Carbon because it is the most efficient and economical control measure for tastes and odors in raw water supplies.

Make your plans now to attend the 61st Annual Meeting of the American Water Works Association, Toronto, Ontario, Canada, the week of June 22-26, 1941.

INSURES PALATABLE AQUA NUCHAR AQUA DRINKING WATER



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Results mean more than words. Talk is cheap and anyone can make a lot of unproved claims. But on the job a pump must do its own talking. Try out a G & R pump and then YOU be the judge.

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AGAIN THE CONTRACTORS BOUGHT GORMAN-RUPP

On the new Shore Parkway project at Brooklyn two centrifugal pumps, one an 8-inch and the other a 4-inch, clogged and quit. Two "Can't Clog" G & R 6-inch pumps replaced the quitters and for weeks pumped 24 hours per day.

Gorman-Rupp Pumps Can't Clog. They are not quitters. That's why MORE CONTRACTORS ARE STANDARDIZING ON GORMAN-RUPP PUMPS THAN ANY OTHER MAKE. They will pump MORE WATER and pump MORE HOURS at LESS COST. THE MOST DEPENDABLE PUMPS FOR THE LEAST MONEY.

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a stopping place modern in every detail, yet maintaining a friendly atmosphere and hearty hospitality • preferred by experienced travelers • dining room • garage adjacent • rooms from $1.50 • with bath from $2.50

cincinnati, ohio

noted that the unaccounted for water has been reduced from an average high of 40% to an average of 21%. This is a reduction of over 2,300,000 gals. per month, which, for a small plant, is considerable. There is still too much unaccounted for water but we are finding it increasingly difficult to make substantial gains in reduction. It is to be understood that these figures fluctuate from month to month but we are encouraged as the trend is still downwards. Each month's ups and downs in percentage of unaccounted for water is paralleled by a corresponding up or down in revenue per thousand gallons pumped. This is as it should be.

It will be noted from the above data that we are pumping an average of 560,000 gallons less per month at this time, than we did in early 1939, but that we are selling an average of 934,000 more. In early 1939, when pumping an average of 12,240,000 gallons per month, we received for it $2980 gross. In late 1940, when pumping an average of 11,680,000 gallons per month, we are receiving $3367 for it. This is an increase of $387 per month gross revenue or $4644 additional gross revenue per year.

We have installed new or repaired meters on 30.2% of our metered services. The cost of this program to date is as follows:

New meters	$2,009
Meter repair parts	458
Portable test meter	50
Meter test bench	175
Field testing of meters	377
Miscellaneous costs	100
Total cost	$3,169

At this rate, with $387 additional gross revenue per month, we will get our money back in a little over eight months. It is needless to say that this additional gross income, falling as it has on some 517 customers, has resulted in an unusually large number of complaints. Yes, they have made the welkin ring. All waterworks Superintendents will "savvy" this.

This 2,483,000 gallons or 21% of unaccounted for water still remaining can be distributed to the following: 1. Distribution leaks; 2. Under-registration of meters; 3. Losses through unmetered services. It has been found from tests that the average water distribution system will leak 206 gallons per inch of pipe diameter per mile of pipe line per day. Applying this formula to our distribution system we have per month the following:

0.40 miles of 10" pipe with an estimated leakage of	24,720 gals.
2.12 miles of 8" pipe with an estimated leakage of	104,813 gals.
6.20 miles of 6" pipe with an estimated leakage of	229,896 gals.
14.65 miles of 4" pipe with an estimated leakage of	358,440 gals.
2.32 miles of 2" pipe with an estimated leakage of	28,675 gals.
	746,544 gals.
25% added for our bad conditions	186,456 gals.
Total estimated distribution leaks	933,000 gals.

A new water balance can now be struck as follows:

Water pumped per month, average	11,680,000 gals.	
Sold, metered and minimum rate	7,937,000 gals.	68%
Given away	807,000 gals.	7%
Plant use	463,000 gals.	4%
Distribution leaks	933,000 gals.	8%
Underregistration and unmetered services	1,540,000 gals.	13%
		100%

There is a limit of 8% to the reduction of unaccounted for water that we can hope to attain; 8% of an

(Continued on page 35)

Engineers may design . . .

BUT FEAR BLOCKS THE WAY

BIGVILLE — and many another thriving community, for that matter — has it's kindly old MR. YES, BUT among the City Fathers or engineers. Let someone offer a new and better way to do a thing; advocate a progressive idea, and he's in his glory. For squelching things he uses a very neat technique. No matter how clean cut, far-reaching and advantageous a move might be, you can count upon him to block it, by parading a lot of fears that start with "YES, BUT".

No City Father, Commissioner or Engineer need fear the adoption of designs or equipment for the sanitary disposal of municipal solid wastes, including sewage sludge, screenings, grit, garbage, rubbish or industrial wastes offered by this organization. For "Incineration Headquarters" maintains an integrated program of laboratory and field research. The coordination of laboratory research, plant design, operation and field experience makes it possible for this organization to offer only tried and proven equipment of the most advanced design. There's no reason why you and your community should accept an outmoded practice, just because that's the way they do it over in So and So. Progress has been made in the science of incineration as in road building, as in lighting, as in municipal management itself. What's good enough for some other place may not meet your local needs at all.

So if your community has a waste disposal problem, get in touch with "Incineration Headquarters". You will secure the benefit of the knowledge, experience, resources and cooperation of the best equipped organization in America to solve these problems.

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When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 55, 56 and 57

Managing Street Cleaning Equipment on a

By GEO. H. ELLIOTT, JR.

Associate Engineer, Bureau of Street Cleaning, Baltimore

THE Bureau of Street Cleaning of Baltimore, Md., each year cleans 150,000 miles of streets and 22,500 miles of alleys; also flushes 50,000 miles of streets. It collects garbage, ashes and rubbish from just inside the rear gate of 65% of the buildings and from the street in front of the other 35%. During the year it makes 117 collections of garbage, 78 of ashes and 52 of rubbish; also collects 65,000 dead animals and 325,000 gallons of waste oils and greases.

The equipment used in rendering this service is as follows:

Number	*Chassis*	*Type of Body*	*Assignment*
46	2½-tons	Enclosed dump	Garbage
55	2½-tons	Special open dump	Trash
23	3 -tons	Open dump	Ashes and street cleaning
14	1½-tons	Open dump	Ashes and street cleaning
2	1½-tons	Enclosed dump	Scavenger
11	1½-tons	Enclosed dump	Street cleaning
5	3 -tons	Hvass flushers	Street cleaning
2	3 -tons	Gar Wood flushers	Street cleaning
3	Motorcycle tractor trailers		Garbage and
1	Small greasing truck		trash

Effort is made to purchase equipment to fit the job to be done, thus assuring low operating cost and satisfactory performance over a long period of time.

The bureau works up the cost of operation of each piece of city-owned equipment for the period of each calendar year. The records kept for this purpose give the total number of hours in service, and the product of this and the hourly rate is charged as a rental against the particular service or operation to which the equipment is assigned.

All operators are experienced chauffeurs and each is regularly assigned to the same truck. They are required to make out daily reports, including those covering accidents, and are responsible for the cleanliness of their equipment. They are not permitted to make any repairs or adjustments to the equipment, but report needed repairs on special forms, the form remaining with the truck until the repair has been made and approved by the shop superintendent. They also fill in forms designated as the "daily service record" and the "fuel ticket," on each of which are recorded the daily meter readings both in and out, while the gas and oil are recorded on the fuel ticket.

The daily service record gives the elapsed mileage for the day, the hours in service, the number of loads hauled, and the tonnage if the materials are weighed. These are given each day to the clerk in the chauffeur's district headquarters and forwarded by him to the Cost Division, as is also the total amount of gas and oil disbursed by the pump at this location and a "material ticket" covering all receipts of materials for that day.

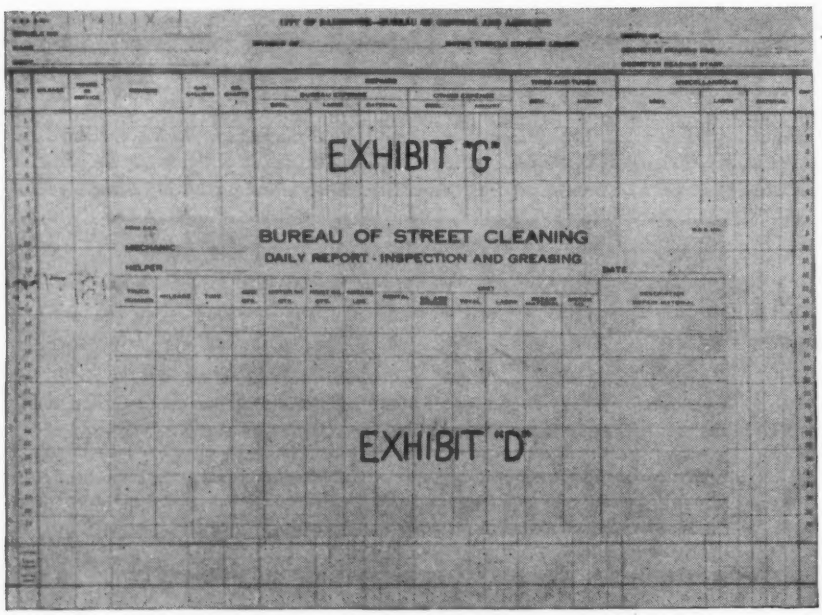


Exhibit C—Page of motor vehicle expense ledger.
Exhibit D—Daily inspection and greasing report.

Should motor trouble develop, the chauffeur calls the repair shop and a service man is sent if the truck cannot reach the shop under its own power.

Each piece of equipment receives regular attention by frequent inspections and greasing by means of a small greasing unit operated by a mechanic and helper, this unit being equipped with an auxiliary motor, air pressure tank and alemite gun. In greasing the equipment the mechanic also checks the carburetor, distributor, generator, battery, horn, fan-belt and brakes and the spark plugs. This method saves much lost time and unnecessary mileage over the previous method of sending each truck to the shop each month.

The repair shop is fully equipped and is directed by a shop superintendent and employs a number of qualified mechanics and helpers. These mechanics change all tires and make minor repairs on the street, also handle all types of repairs in the shop

a Rental Basis

At the right are shown several of the cards used for collecting the data for developing the various operation costs—fuel ticket, daily service record, employees' daily time slip and material requisition.

except complete overhauling, which is usually done at the general repair shop of the Bureau of Mechanical-Electrical Service.

The Cost System

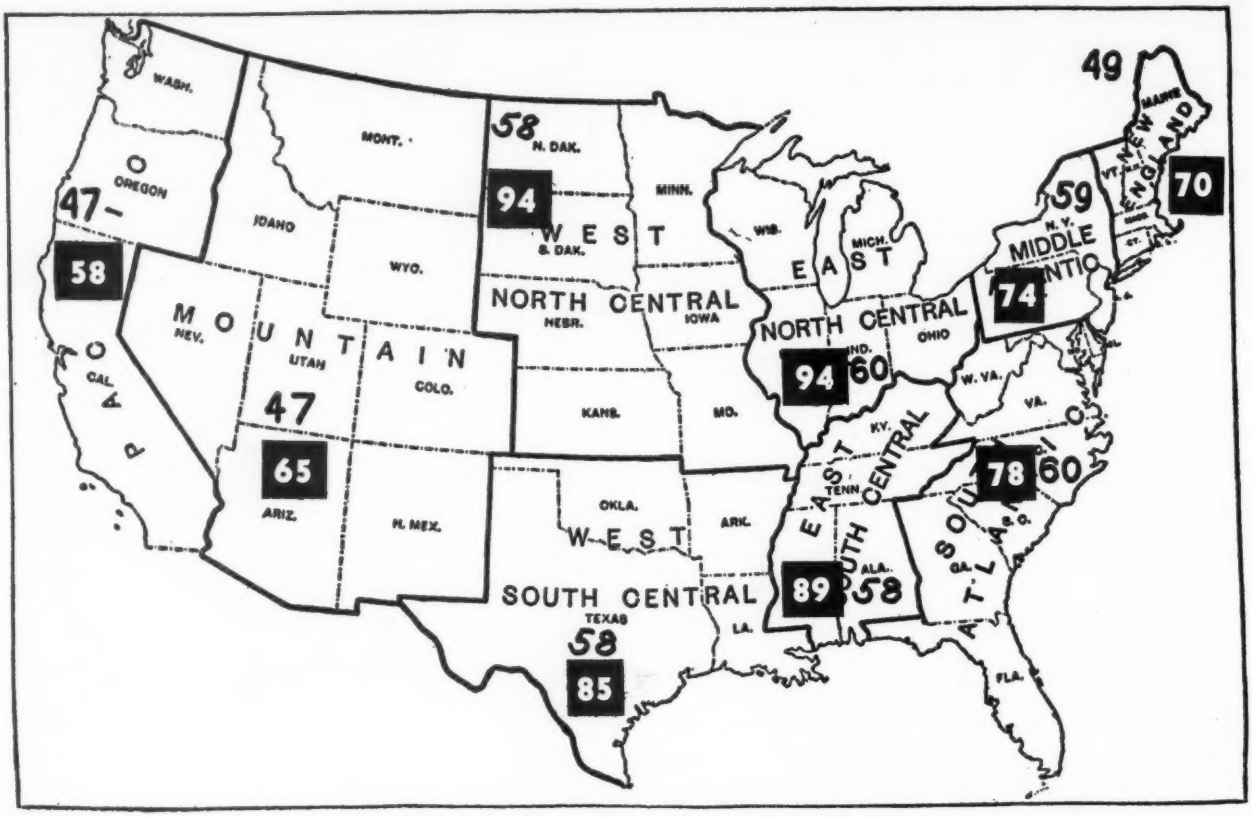
Before setting up the cost system, study was made of systems in effect in a number of large organizations, which disclosed that the general trend of all commercial companies is to eliminate all unnecessary detail figures except the ones which experience has shown are vital to the control of transportation costs. In general, the various companies place more emphasis on keeping operating costs by groups of vehicles rather than by individual units. All companies investigated compute the comparative figure for the type, make and unit of operation.

In order to obtain information necessary to develop the costs of operation, the bureau has records entered on 8 forms as follows: 1. Mileage or performance ticket; 2. Gas and oil fuel tickets; 3. Employees' daily time slip; 4. Machine material tickets; 5. Daily time sheets; 6. Service orders; 7. Material requisitions; 8. Interdepartmental bills. This information is posted daily on the monthly ledger sheet for each truck each day, and at the end of each month this ledger sheet is totaled on all items. These records on the monthly ledger sheets are transcribed annually to the history ledger sheet.

Data for calculating the operating cost of motor vehicles during a calendar year include the mileage operated and miles per gallon of gasoline; cost of gasoline, oil, repairs, accidents, tires and tubes, garage and miscellaneous expenses. Depreciation is charged according to a standard schedule; for equipment up to 1½ tons, 35% depreciation is charged the first year, 25% the second, 20% the third and 10% the fourth and fifth years. For equipment over 1½-tons the rates of depreciation are successively 30%, 20%, 15%, 12%, 10%, 8% and 5%. Each vehicle is insured for fire, theft and liability and the amount charged against it. From these figures the cost per ton mile is calculated for each truck.

The city owns only such equipment as can be worked steadily throughout the calendar year and a number of trucks are hired each year during the heavy ash season. Trucks of 2½ and 3-ton capacity are hired at the rate of $2.00 per hour, which includes chauffeur, all operating expenses and insurance. City-owned equipment of the same size and type is operated at a cost of $1.35 per hour. The desirability of this practice was investigated by a committee consisting of a certified public accountant and various cost and transportation officials of several public utilities, which approved the policy.

From the 1939 figures, the hourly rate of operation of trucks is found to be 81c, the mile rate 16c and the ton-mile rate 12½c. Had the bureau hired all the equipment and not owned the 162 pieces of city equipment, the additional outlay would have been $125,000. Abstract of paper before American Public Works Ass'n.



In each geographical division, the smaller number represents the percentage of cities reported as 100% metered; the larger number, those 90% metered or more.

How General is Metering?

A typical cross-section of United States cities shows that the number of those 100% metered is increasing. Only about half, however, take adequate measures to insure that the meters maintain their accuracy

OF QUESTIONNAIRES sent a few weeks ago to water departments of American cities, several hundred have been returned, 750 at the time this summary was made, these including cities in all states throughout the country. Some of the questions asked referred to meters, which is the subject considered in this particular summary. Of all cities reporting, 60% reported that 100% of their services were metered. 81% reported that 90% or more were metered, while only 9% reported less than 25% metered. (7 reported none, and "mills," "factories," "commercial," "all but free water," and "all but parks and public buildings" one each.)

Grouping the figures by geographical divisions, we find 100% metered in 69% of the East North Central states, 60% of the South Atlantic states, 59% of the middle Atlantic states, 58% of the East South Central, West North Central and West South Central states, 49% of the New England states and 47% of the Mountain and Pacific states. Considering the cities in which 90% or more of the services are metered, we find this reported from 94% of the cities in the West North Central and East North Central states, 89% of the East South Central, 85% of the West South Central, 78% of the South Atlantic, 74% of the Middle Atlantic, 70% of the New England, 65% of the Mountain states and 58% of the Pacific states.

The question was asked "How often do you test your meters for accuracy. Only 53% of the cities reported any definite system of accuracy tests. Two reported testing after the meter has passed one million gallons, one after it has passed 75,000 cu. ft. and one after it has passed 100,000 cu. ft. Six report testing large meters once a year and small ones once in five years, and two test large meters once in two years and small ones once in ten years. Of those reporting any definite system, 36% test once in 5 years, 6% once in 10 years and the remainder at various intervals ranging from one year to 20 years, but only 5 above 10 years. Seven percent test biennially, 7% once in 4 years and 7% once in 6 or 7 years. Quite a number which are not included in the above statement report testing for accuracy whenever the meter is removed for repairs, "when suspected," "when necessary." A few honest officials report that they test meters only when they stop altogether. Presumably the 47% which did not reply to this question have no fixed schedule for testing.

It appears from the above figures that 100% metering is most general in the cities of the Mississippi

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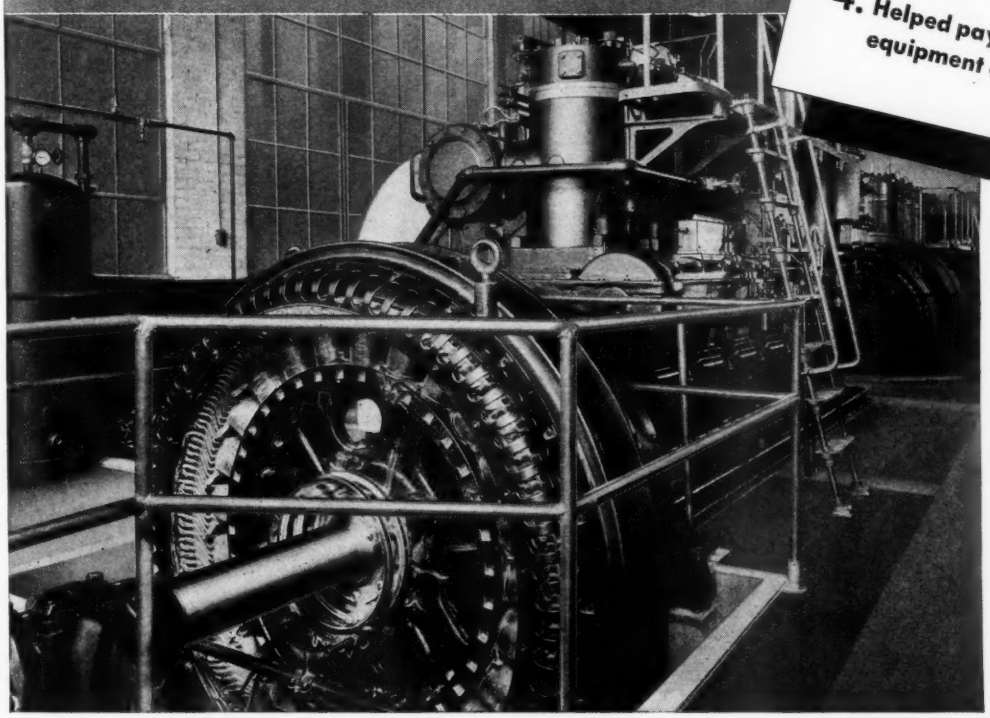
Garland's Original F-M DIESELS:

1. Earned $8772.84 profit in 1939.
2. Reduced taxes by providing free street lighting.
3. Reduced taxes by providing free water supply.
4. Helped pay for fire-fighting equipment and its housing.



Garland's new 5-cylinder Model 33 F-M Diesel, rated 575 h.p. at 300 r.p.m. The directly connected 490-kva alternator with "V"-belt-driven exciter is also of Fairbanks-Morse manufacture. In background, 4-cylinder F-M Diesel installed in 1930.

LOW operating cost is the reason for the fine earning record (above) of the Garland, Texas municipal power plant.

A major factor contributing to low operating cost is *low maintenance cost.* Records at Garland, as in hundreds of other plants, *prove* that Fairbanks-Morse Diesels stand up under continuous heavy-duty service with a minimum of simple, inexpensive servicing.

That is because F-M Diesels for generating electric power are slow-speed engines in which wear is slow. And because they are two-cycle engines—efficient, simple, with no valves to grind, no electric ignition system to service. And because they are designed and built to permit continuous operation at full rated load without damaging strain or overheating.

Whether equipping a new plant or expanding your present one, take a tip from Garland and learn how the low maintenance cost of F-M Diesels can earn profits and reduce taxes for your city or town. Write Fairbanks, Morse & Co., Dept. B67, 600 S. Michigan Ave., Chicago, Ill. Branches and service stations throughout the United States and Canada.

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Diesels

When you need special information—consult the *classified* READER'S SERVICE DEPT., pages 55, 56 and 57

Valley, and least so in the mountainous states of New England and the Pacific Coast. It appears probable that this is because cities in the mountainous districts obtain their supplies by gravity without cost of pumping and can obtain them in abundance and therefore are not so interested in controlling the consumption.

A number of the cities replied that they made accuracy tests of their meters annually and, in order to be sure that our question and their replies were definitely understood, we asked for further details from a number of them. Several of the replies received were as follows:

H. W. Coleman, Town Manager of Vinton, Va., states that each meter is taken out, cleaned and tested once each year and some oftener. J. L. Mason, Asst. City Engineer of Modesto, Calif., says that. "on account of the presence of fine sand in our water, which is from a well supply, it is necessary for us to clean small meters approximately once a year. All meters are retested after cleaning or reconditioning. The ¾" and 1" meters are tested on an average of once a year. The larger meters are tested at approximately 2½ year intervals except that meters on 3" services and larger may remain untested for an indefinite length of time."

Reducing Waste

The question was asked, What measures are taken to reduce waste?, and 152 reported making some effort along this line. Fifty-three of these rely entirely on meters; one specifying that they meter free water.

Inspection is the next most common method, 41 cities employing it. Of these, 13 say they inspect only "occasionally"; 16 inspect "regularly" and others once a year, twice a year, every two years, etc. Two inspect only flat rate premises. These, we understand, refer to inspection of plumbing in consumers' premises. Several also make regular inspection of valves, hydrants and sewer flush tanks.

Other methods reported are checking pumpage, watching night flow, controlling use of hydrants, limiting sprinkling, securing cooperation of consumers, use of leak detector, inspecting flow in sewers. Six make pitometer surveys at intervals. Repairing leaks, including leaky valves, and replacing old services with copper or other pipe are reported by several under this head.

Valve Maintenance

Not so many years ago it was common practice to pay no attention to underground valves until an effort to close or open them met with failure. Some valves never had been operated; many were leaking; some were entirely forgotten, no record having been made of them when the mains were laid. In quite a number of instances valves have been found closed, and so far as any record or memory went always had been closed, although intended to be open.

This, of course, was all wrong; and any superintendent today who is up to date makes periodic inspections of all valves and remedies defect found.

Of 460 cities reporting to us, 50% make yearly inspections, 11% semi-annual; 18% inspect large ones yearly, the smaller ones less often. Eight report quarterly inspections. Others inspect on an average of once in 2, 3 or 5 years. "When necessary," "when they leak," "when used," etc., are among other replies.

(Continued on page 35)

Cafe Monaco
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One of the most distinguished Restaurants between New York and Chicago
THE NATURAL MEETING PLACE FOR MIDWESTERN BUSINESS MEN

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MANHOLE COVERS, WATER METER COVERS, ADJUSTABLE CURB INLETS, GUTTER CROSSING PLATES, VALVE AND LAMPHOLE COVERS
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This Advertisement Carries a Coupon and Here's Why

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STANDARD ACTIVATED ALUM

is a very powerful water works coagulant, recognized as the coagulant to use when dealing with waters which are difficult to handle—*fast being recognized as America's most popular coagulant.*

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is the only coagulant manufactured containing powdered activated carbon. This coagulant is recognized as the most efficient available for water works practice, *because it will actually remove tastes and odors from water supplies.* It is made from Standard ACTIVATED ALUM and costs $2 per ton more because of its activated carbon content. Truly the "Alum of Tomorrow available Today" for those who demand the best in Everything.

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BLEACHING CLAY

—Aids coagulation
—Increases absorption of organic matter
—Costs less than $20 per ton on the average
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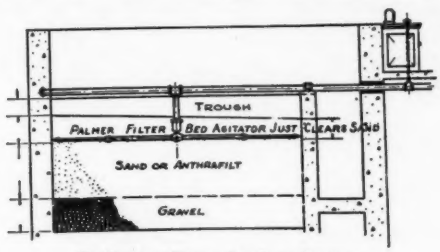
SURFACE WASH

PALMER FILTER BED AGITATORS

Developed at Erie, Pa., by C. E. Palmer—awarded the President's Cup for outstanding performance—praised by editors and engineers alike—the latest



Palmer filter bed agitator

thing in water works practice—28 new installations in January. Over 400 now in service.

USERS REPORT

- complete elimination of mud balls
- no more cracking or shrinking of beds
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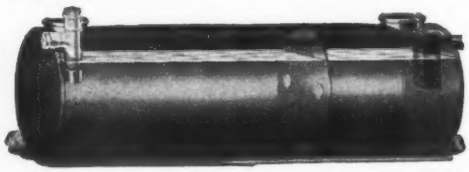

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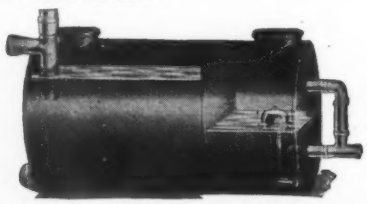

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Telling It to the Jury

By P. L. BROCKWAY
City Engineer, Wichita, Kansas

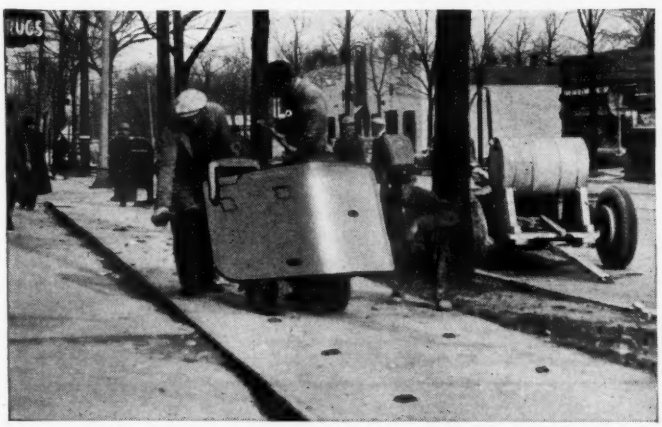
THE article written by Nathan Young on "How to be an Expert Witness," published in July PUBLIC WORKS, is worthy of further discussion. Certainly, it contains good sound legal theory backed in true legal form by citations from supreme court decisions. The advice in the closing paragraphs as to the attitude and integrity of the witness is eminently sound and in line with all professional ethics of the engineer.

It must be kept in mind that civil cases are brought to court to invoke the power of the court to enforce the plaintiff's claims and the defendant must answer the claims all within well established court procedure. The plaintiff employs an attorney to obtain his just rights through the court; that is, all he can get in most cases. The plaintiff submits all his facts to support his claims, the attorney searches the laws and decisions which will favor the plaintiff's facts, and defendant is notified.

The conduct of the mine run of lawsuits by the opposing attorneys does not impress the observer as an honest, open attempt to see that real justice is accomplished. Witnesses are obviously coached both as to direct testimony and as to probable cross-examination. Honest differences of witnesses as to facts are magnified. Credibility of bewildered witnesses is attacked by adroit lines of questions. Questions are shouted at witnesses with threatening gestures by some cross-examiners.

An attorney once told me that one of his instructors had advised the class never to get into an argument with an expert witness on the subjects with which the expert is familiar. "Get him to arguing law on the question and then you have him." It occurred to me that the witness might use that advice in reverse in the clashing of wits. It is perfectly dignified to ask to have an involved hypothetical question repeated. If the average attorney attempts to repeat, he is very apt to become tangled up. If he asks the court reporter to read the question, it is apt to be incomplete, and the witness can honestly and simply say that the question cannot be answered.

An incident to illustrate the difficulty of making a complete hypothetical question:—An engineer witness in a drainage case was being cross-examined on the boundaries of a drainage district. He had testified that ground on a certain street was higher near the ditch than at a point a block away from the ditch but was in doubt about direction of surface drainage on the street. The attorney interrupted with a hypothetical question as to which way the water would flow in a block with the ground higher at one end than the other. The witness attempted to qualify the answer but was peremptorily challenged to make a direct, un-



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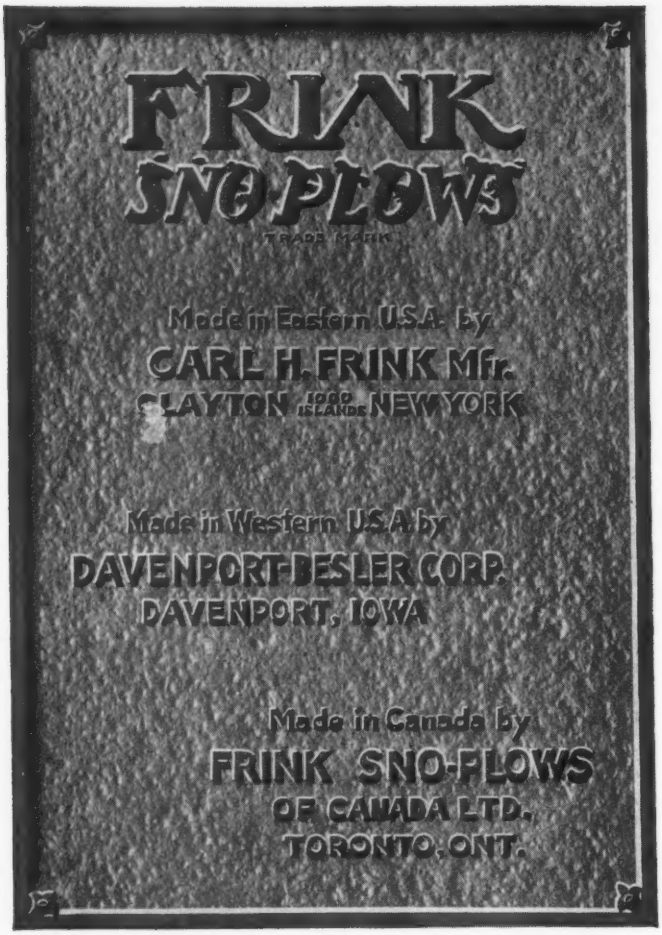

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qualified answer. The witness answered "I don't know." Then a volley of shouted questions on the professional qualifications of an engineer who didn't know the answer to so simple a question. The witness asked and was given permission to tell the court and jury why he didn't know. He simply said, "Because you haven't told me what is in the middle of the block." The hypothetical question was distinctly leading, a device frequently used to trap an unwary witness.

Double questions must be analyzed before an answer is made; the last half may be innocent enough but the same answer to the first half may be entirely wrong. There is no rule of evidence which prevents a witness from pointedly and deliberately answering each part separately if the opposing attorney does not have the question thrown out by objecting. Leading questions and repeated questions may, of course, be thrown out on objection of opposing attorney. It must be remembered, however, that all of the attempts of the attorney for either side to introduce evidence favorable to himself and unfavorable to the other is calculated to influence the jury in his favor. If too many questions are blocked by objections, it is apt to prejudice a juror who doesn't know what it's all about and who doesn't know or care about rules of evidence. The witness may easily take care of himself by confining himself to simple statements of facts as he knows them. He is nearly always permitted to refer to notes to refresh his memory. If he is in doubt or has no personal knowledge, it reinforces all he has said to say so.

Long answers and technical terms are most certainly out of place. The famous answer of the engineer who had made the statement that the size of the lake made no difference in the pressure on a dam illustrates the value of simple, understandable language. When challenged, he reminded his questioner that the mud dikes of Holland hold out the Atlantic Ocean.

As to the admissibility of expert opinions, it seems best for that point to be determined by the court. It is easily conceivable that there would be very close decisions on that point. If the question requires only a statement of fact, the answer is clearly not an opinion. If, however, the question calls in a degree for an interpretation of stated facts which interpretation calls for special knowledge, the witness should properly start his answer, "In my opinion . . ." This keeps his statements clear to the jury and, if the case is appealed, the higher court can pass on its admissibility as an opinion and not as an assumed fact.

Again reminding ourselves that the jury must pick out the facts from the conflicting statements, witnesses must at least appear to be perfectly honest, frank and willing to set out a true picture of the points at issue. Little things may lead a juror to doubt you, even a physical attitude of over assurance or an obvious mental hostility. I have known a successful trial attorney who constantly watched the jurors to see their reactions to his line of questioning, suddenly abandoning or elaborating as he found advisable.

I do not intend to create the impression that there is any lack of decorum in court procedure, that attorneys will not prosecute the case well within the accepted rules of evidence, or that the judges will admit things which are not pertinent to the case. I am emphasizing, however, that the foundation of the case is ill will between individuals and that the actual trial before the court is a battle of wits in which each is trying to obtain advantages of the other.

Any witness, and especially an engineering wit-

ness, testifying as to facts and opinions should not permit the interests of his client to color his testimony. If he does, he is injuring his credibility and certainly not helping his reputation. He should not answer questions too quickly. In the first place, the opposing attorney may want to raise an objection to the question and, in the second place, his answer should not appear to have been rehearsed beforehand but rather should be the result of deliberate thinking. He should as far as possible use language which is understood by the layman who must pass on his replies. He should speak slowly and distinctly so that the court reporter can make a clean, clear record and the jury can easily follow his replies. He should not be lulled into a relaxed attitude by a series of routine questions but should be continually alert lest he be led into admitting so many small parts of the whole that he has admitted the whole. He should not assume an attitude of superiority. In short, he should tell the truth, the whole truth and nothing but the truth, and be very careful how he tells it.

Water and Sewage Chemistry and Chemicals

In the preparation of the article with this title, which appeared in our December issue, Mr. Hardenbergh was assisted by a number of engineers and chemists, a list of which was given therein. Much to the regret of the author and the editor, the name of *Ellis K. Phelps* was omitted from the list in the press of making the article ready for the printer.

Mr. Phelps prepared the section on "Ionization" and advised the author on many points during the process of preparing the article, and also read the entire text. This assistance, based on a knowledge of the water and sewage field, was invaluable and was greatly appreciated.

Reducing Unaccounted for Water

(Continued from page 24)

average monthly pumping is 934,000 gallons. This is about equal to the estimated former distribution leaks which we have stopped. Considering the age of our system, the quality of construction and the soil conditions, the prospect does not look inviting for further gains in that direction. But the losses due to the under-registration of meters and of unmetered services, amounting to 1,540,000 or 13% of an average month's pumping, is a fertile and promising field for our continued efforts.

How General Is Metering?

(Continued from page 30)

Nineteen percent report inspecting at irregular intervals.

About two-thirds of these cities report more or less regular oiling and packing of valves. Of these, 26% service the valves yearly, 4% semi-annually, and 1% quarterly. Others report intervals varying from 2 to 10 years. Only 2 admit never oiling their valves. Eleven percent have no regular time. Others service valves when "necessary," "leaking," "used," etc.

If we assume that the 165 cities which answered the other question but failed to answer this do not oil and pack their valves regularly, we find about one-third of the entire number making a practice of periodically oiling and packing valves, and another third doing so at irregular intervals.

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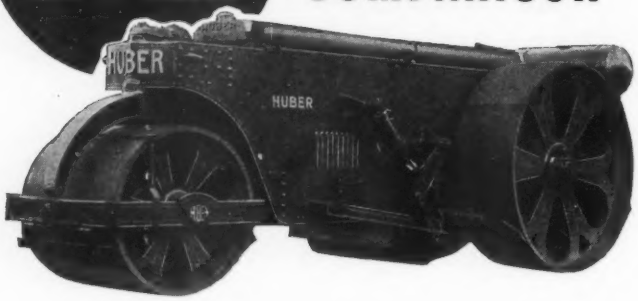

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Airport Snow Removal and Ice Control

AIRPORTS present a rather special problem in snow removal and, to a lesser extent, in ice control or anti-skidding work. Snow removal is especially complicated by the fact that the runways are normally very wide as compared to highways. Even on a small airport, a runway may be 3000 feet long and 150 feet wide, and this is equivalent to a 20-ft. highway more than 4 miles long. Where there are several such runways, the yardage to be cleared is considerable.

Due to the need for maintaining a wide cleared space, the usual so-called "high-speed" snow removal equipment—the one-way plow operated at 25 to 40 miles per hour—cannot be used effectively. Such plows do not throw the snow far enough to the side to clear the runways and thus it must be handled several times. In addition, time is lost in turning at the ends of the comparatively short runs. V-plows similarly are not well adapted in most cases to runway snow removal.

The reversible blade snowplow is about the best snow removal unit for airports; and when these are supplemented by rotary brooms, a clean surface can be maintained under nearly all conditions. This combination, in addition to being effective, makes a good team, utilizing generally the same type of motive equipment and the same connections.

In this type of plow, speed is not a factor in operation, and the snow is pushed ahead of the blade; operation may be at right angles to the centerline of the runway, or angling to it. Reversible blade plows are available in sizes suitable for nearly all trucks or other motive power. Reversible blade plows are made by about a dozen manufacturers; in general all of these are similar in design and vary principally in details of construction.

Reversible plows are made in sizes ranging from about 8 ft. long and 2 ft. high for trucks up to 1½ tons rating, up to 11-ft. blades for 5-ton or larger trucks. Also, several manufacturers of motor graders furnish plows especially designed for use with these units. Wheel tractors are excellent for this work also.

Brooms are excellent for removing the lighter snow falls and for cleaning up after the plows in the case of heavier snowfalls. The usual type of broom is the rotary, attached to a truck, wheel tractor or motor patrol or grader, and powered either by a takeoff or by an independent motor.

Ice control follows the same principles as in the case of streets and roads, except that the use of mechanical spreading equipment is still more economical and desirable, due to the width of the runways and the frequent necessity for prompt treatment to prevent danger from slippery surfaces. Special attention should be given to the area around the hangar.

Cinder or sand may be used, but should be treated with calcium chloride or salt to be most effective and economical. The methods of preparing such material with both salt and calcium chloride were described in considerable detail in the October issue of PUBLIC WORKS, page 31; and on preceding pages descriptions of the various equipment used in highway snow removal were given.

Under any conditions proper planning is essential and provision must be made for the necessary equipment, both plows and motive power, to provide for

quick removal. The area that a truck or tractor-operated reversible blade can clear should be known for local conditions, and this will determine the amount of equipment. Similarly, the area that a motor broom can clear per hour will determine the amount of this equipment. Careful planning and good management will aid in utilizing such equipment to the maximum advantage.

The Sewage Treatment Plant at Winner, S. D.

Winner, S. D., has put into operation a sewage treatment plant, replacing an outworn plant which was inadequate to serve the needs of the growing community. The new plant, located near the north city limits and built with WPA labor, was designed to handle the future needs of more than twice the present population. It is described briefly in "The Clarifier," published by the South Dakota State Board of Health.

Following clarification in the primary settling tank, 24′ x 8′ x 7′ deep, the sewage flows by gravity to the central distributor of the small circular rock filter. The latter, one of the features of the plant, is a high-rate filter, the applications of which have been increasing rapidly in the past few years. The flow between primary tank and filter is continuous, without the usual rest period as on most rock trickling filters. Distribution of the sewage over the filter, which is 22 feet in diameter and 8 feet deep, is accomplished by motor driven spray arms, or splash plates upon which the overflow falls from a vertically placed influent pipe.

Following filtration, the flow is carried by gravity to the secondary settling tank for final sedimentation treatment. From there it enters the outfall sewer, 8,800 feet of 12-inch tile laid from 9 to 12 feet deep, to a small creek about two miles north of the city. All flow through the plant to the outlet is by gravity.

During periods of low flow, it is necessary to recirculate part of the sewage in order to maintain a fairly uniform rate of application to the filter. This is accomplished by pumping from the secondary settling tank back to the primary settling tank by means of a recirculating pump.

The method of handling and disposal of sludge has been used in only a few other plants in the country to date. Sludge is first pumped from the primary and secondary settling tanks to a sludge conditioning chamber, a concrete tank 4½ feet square and about 7 feet deep. Here ferric chloride is applied at the rate of about 2,000 p.p.m. and is distributed by mechanical mixers. The resulting mixture is run out on small sludge drying beds to dry. The sludge pumping, mixing and drying is conducted as a daily operation to prevent septic action from occurring in the settling tanks.

The sludge, when treated with this amount of ferric chloride, gives up its moisture readily and the water has been found to drain so that the sludge may be handled and removed within 10 to 24 hours. Treated in this manner the sludge is sterile, quite stable, and contains excellent material for use as fertilizer.

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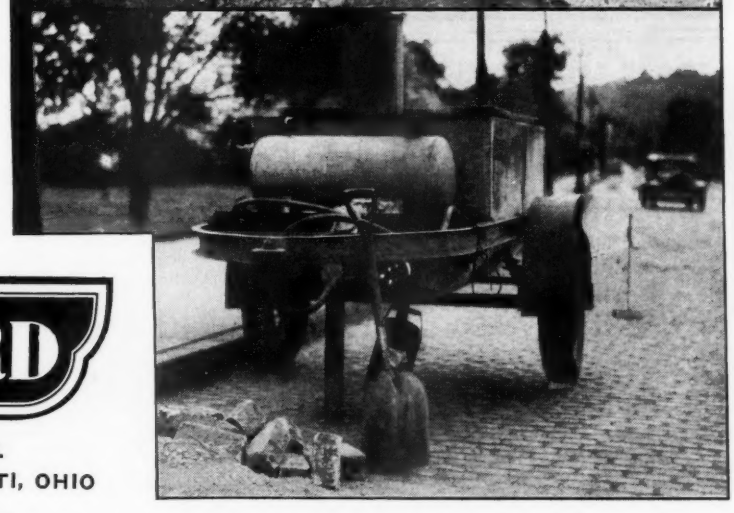

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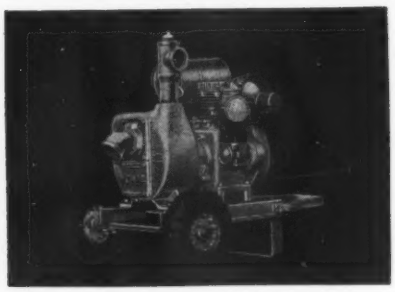

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The Dewatering of Sludge by Vacuum Filtration

(Continued from page 16)

Kinds of Filter Cloth. — Practically all vacuum filters use either cotton or wool cloths. There are some 25 grades of cotton cloth, a number of which are suitable, depending on the type of sludge. Cotton should always be used when lime is employed as a conditioning chemical. Wool cloths, which are more expensive, are employed for activated sludge, elutriated digested sludge or wherever ferric chloride is used without lime. From 250 to 300 hours of service is common for cotton cloths; much longer for wool cloths.

Cloths made of rubber, monel metal, glass and other materials are available and special conditions may sometimes justify their cost.

Care of Filter Cloths.—In addition to their normal usage, filter cloths are deteriorated by waste crankcase oil, grease, acids, alkalies, the chemicals used for conditioning, and by lack of proper maintenance. As cloths age they require greater quantities of conditioning chemicals for satisfactory sludge filtration, until a point is reached when it is more economical to change cloths. It is important to remember that the cost for chemicals is the largest item of cost in vacuum filtration, out-rating power or other costs.

The life of cloth is lengthened by (1) correct adjustment of the scraper; (2) use of the optimum amounts of conditioning chemicals; (3) occasional use of a 2½ per cent hydrochloric acid wash, if lime is used; (4) frequent application of a mild soap or trisodium phosphate solution applied with a brush; (5) thorough washing with water before and directly after each filter run; (6) avoidance of excessive cloth stretching and use of the proper wire tension (the cloth is held in place on the drum with either steel or bronze wire); (7) prompt repair of small holes or tears; and (8) frequent cleaning of the supporting wire mesh with stiff brushes and solutions or its removal for sand blasting, hammering or other treatment as required.

Sludge Conditioning.—The proper conditioning of the sludge is the most important factor in successful filtration. Ferric chloride and lime are best added to the sludge as relatively weak solutions, the primary reasons being better mixing and easier conveyance.

Ferric chloride should be stored, mixed and conveyed in specially treated equipment. Rubber-lined tanks and rubber hose or rubber-lined pipe are most frequently used. Metal, wooden or other common containers may be used for lime. The lime should be high in calcium oxide and low in magnesium oxide, since magnesium hydroxide rapidly ruins filter cloths.

There is with most sludges an optimum amount of chemicals which should be used, either side of which adversely affects filtering. This amount may be determined by laboratory tests described later.

The chemicals are added to the sludge either continuously or by batch mix. Direct draw-down of the prepared chemicals by gravity to the mixing or conditioning tanks is usually practiced for batch mixes. Mechanical feeders, preferably of the displacement type, are used when the conditioned sludge is fed continuously to the filters.

Figure 1 shows an arrangement utilizing a hard-rubber lined pump which both lifts ferric chloride to the conditioning tank and proportions the flow of chemical to the rate of sludge feed. Figure 2 illustrates

such an arrangement at the Pigs Eye Island sewage treatment plant in St. Paul, Minn.

Sludge, whether raw or digested, can contain either too low or too high a percentage of solids for satisfactory conditioning and filtration. If the solids content is below 5 per cent conditioning is frequently less economical and a less satisfactory cake is obtained on the filter. With raw sludge, a solids content of 5 to 8 per cent is an ideal range, while with digested sludge a higher solids content is better, the range from 8 to 16 per cent solids giving good filtering results. The higher the solids content, the lower generally are the chemical costs per pound of dry solids filtered. Sludge can be too heavy, however, and if the solids exceed about 16 or 17 per cent addition of diluting water may be desirable or necessary. Many vacuum filter plants are designed with special sludge storage tanks, which are a convenient means for concentrating or diluting sludge to obtain the solids concentration desired.

When raw sludge is to be filtered, there is generally an advantage in dewatering it as soon as possible, for septic solids require in most cases additional chemicals for conditioning and there is more trouble with cloth blinding.

It is important in raw sludge filtration to control the oil and grease content of the sewage, as these wastes blind filter cloths. Degreasing and oil flotation basins to remove this material are sometimes employed ahead of the regular settling tanks. Enforcement of local ordinances against the discharge of such substances into sewers affords the best protection. Occasionally a vacuum filter plant handling raw sludge containing industrial wastes is actually benefited by the wastes through a decrease in chemical doses required or because the wastes retard septic action. One such instance, where the sludge contains quantities of copper sulphate and other wastes, has been observed by the writer.

Whether batch or continuous mix is employed in sludge conditioning, it is highly desirable that the conditioned sludge be fed by gravity from the conditioning tanks to the filter vats in order to avoid the breaking up of the floc by pumps or bucket elevators. Also the mixing time must not be too long else this too will break up the floc. From 10 to 20 minutes is an average mixing period for most plants for raw sludge, a shorter period for activated or digested sludge. In general, short mixes are preferable; the tendency is to mix too long. Compressed air is sometimes used but gives adequate mixing only with liquid sludge. Mechanical paddles are more commonly used for mixing. Slow-moving adjustable-speed mechanical paddles are preferred.

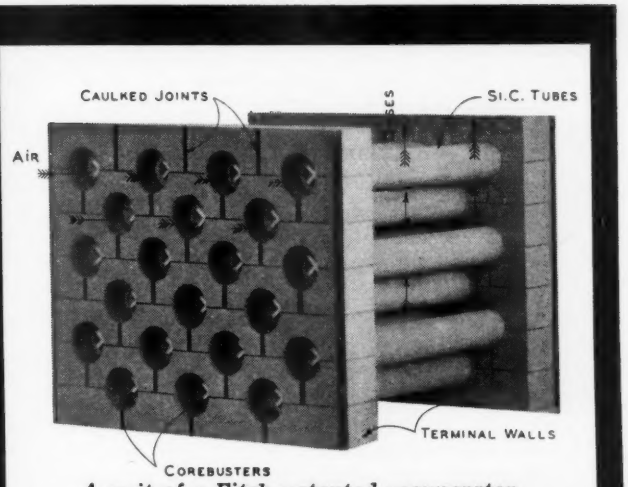
Sewage Treatment Plants for National Defense Projects

(Continued from page 10)

other emergency conditions are likely to change the unit costs found by experience in the construction of sewage treatment plants for municipalities. Present indications are that complete treatment plants with high-rate trickling filters may generally be built for from $4.50 to $6.00 per capita, the smaller the project, however, the higher the per capita cost.

Scum Handling

It is expected that relatively large quantities of scum will be removed from the primary sedimentation tanks. Such scum is usually disposed of either by di-



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gestion with the sludge or by burning in a small incinerator. In either case, at the larger camps, piping and pumps will be required for handling the scum. These should be of ample capacity and sturdy construction, with provisions for flushing and rodding.

Comments on Equipment

Modern sewage treatment plants include many items of mechanical equipment. In purchasing these, the Government requires, in general, competitive bids from two or three manufacturers where possible.

(a) *Screens.* In municipal practice, bar screens at the inlet to sewage treatment plants are frequently provided with mechanical rakes for cleaning. In some municipal plants the screenings are ground and returned to the sewage; in others the preliminary screening is done by comminutors. We do not recommend any type of mechanical cleaning equipment for the screens, but recommend that, in general, they be cleaned by hand.

(b) *Measuring Devices.* Provision should be made at the inlet end of the treatment plant for measuring the quantity of sewage. In our opinion, this can be best accomplished by a Parshall flume, or a Palmer-Bowlus rectangular flume, or a weir. In general, we do not recommend the installation of Venturi meters. In our opinion it would be desirable to install recorders which will provide a continuous permanent record of the quantity of sewage. These are inexpensive and not difficult to maintain.

(c) *Sludge Removal.* Mechanical equipment for the removal of sludge can be obtained for either rectangular or round sedimentation tanks. There are enough manufacturers of such equipment for each type of tank to provide sufficient competition. To permit rapid construction, we advise that the architect-engineer decide whether to build rectangular or round tanks and that the two shapes be not part of the competition.

(d) *Scum Removal.* Scum is usually removed from the surface of the sedimentation tanks by the same mechanical equipment that removes the sludge. In some cases scum has been removed by water or air jets which drive it to a pipe in one corner of the tank. In our opinion the mechanical equipment for the removal of scum is sufficient if the operators at the treatment plants supplement mechanical removal with some hand cleaning or jetting by water from a hose.

(e) *Sludge and Scum Pumps.* Pumps for sludge and scum are made by several manufacturers and are of varied design. The motors for the operation of these pumps should be of ample power, perhaps a little above rather than below the manufacturer's rating.

(f) *Digestion Tanks.* Floating covers without agitators, or fixed covers with agitators can be used. With the amount of grease expected, agitation of the sludge may be advantageous, and provision for some degree of agitation by mechanical means or by recirculation should be considered part of the sludge digestion tank equipment. In addition, the equipment for digestion tanks should generally include heating coils and boilers. Provision should be made for the collection of the digestion tank gas and its utilization for heating the tanks with proper safety devices. Excess gas should be burned.

(g) *Chlorinating Equipment.* Chlorination equipment should be of the solution type. Generally, duplicate units should be installed. Standard sizes with a range of application rates ample to cover the required quantities of chlorine are available. Capacity for a maximum rate of 200 pounds per m.g. for the average quantity of sewage is recommended.

(h) *Miscellaneous.* Other items of equipment include water supply and drainage pumps. Ordinarily the water supply can be taken from the general camp distribution system. Drainage pumps may be required in some cases.

Activated Sludge

The activated sludge process is satisfactory where complete treatment is required, but in most cases is not considered so suitable for the camp projects as trickling filters. Where the activated sludge process is adopted, the bases of design should approximate those followed in municipal practice. It is possible, however, that the sewage solids of the camps will contain a relatively high percentage of volatile matter and this may require somewhat longer displacement periods in the aeration and final sedimentation tanks than in normal municipal practice.

Intermittent Sand Filters

Only in special cases and under favorable conditions will intermittent sand filters be applicable. The basic design allowances for such filters will be dependent upon the local conditions.

Filter Fly Control

Sewage treatment plants comprising trickling filters of the standard or low-rate type should provide for flooding to prevent the excessive growth of filter flies, particularly if located close to the camp buildings. If located upwards of 2,000 feet from the nearest camp buildings, flooding of the filters may not be required. If high-rate trickling filters are built, experience has indicated that filter flies will not be troublesome.

The authors of the report believe that, as the sewage will be quite fresh and contain only small proportions of impurities in solution or colloidal form, chemical treatment would not be worth the cost. Because of lack of time for study, relatively new processes not yet standardized should not be considered. Wooden buildings for enclosures of plants rather than masonry are recommended in interest of economy and speed.

Operation

It is exceedingly important that the treatment plants be operated by competent and experienced men, this being particularly true in the case of the more complicated plants providing secondary treatment. It would be desirable, also, to have some general supervisory agency make occasional check-ups on operating procedures and results.

Laboratory

Each plant should be provided with a small laboratory at which routine tests appropriate for the size and character of the plant will be made. In general the following tests should be carried out:

At Class A plants (providing secondary treatment):
- Settleable solids by volume
- Suspended solids (by Gooch)
  - Total
  - Loss on ignition
- Biochemical oxygen demand
- Relative stability of effluent (methylene blue test)
- Residual chlorine
- pH of sludge

At Class B plants (providing primary treatment only for populations of about 20,000 or more):
- Settleable solids by volume
- Suspended solids (by Gooch)
  - Total
  - Loss on ignition
- Residual chlorine
- pH of sludge

At Class C plants (providing primary treatment only for

populations of under about 20,000):
Settleable solids by volume
Residual chlorine
pH of sludge

Included in the report (but omitted here) are lists of furniture, apparatus and chemicals required for the recommended laboratories and tests.

Sewage Treatment Plants as Installed in the Larger National Defense Projects, 1940

Post	*Location*	*Design Basis Per 24 Hours M.G.*	*Type of Treatment Plant*
Aberdeen Proving Grounds	Aberdeen, Maryland	1.05	Primary trt. Sep. sludge digestion, Chlorination
Fort Belvoir	Ft. Belvoir, Va. (1)	0.21	Primary trt.
	(2)	1.19	
Camp Blanding	Camp Blanding, Fla.	3.5	Primary trt. Sep. sludge digestion, Chlorination
Fort Bliss	Fort Bliss, Texas	2.17	Thru El Paso City Sew. Sys.
Camp Bowie	Brownwood, Texas	2.1	Aero-Filt., Chlorination
Fort Bragg	Fort Bragg, N. C.	4.62	Single-stage bio-filt.
Camp Claiborne	Alexandria, La.	1.4	Act. sludge Chlorination
Fort Devens	Fort Devens, Mass.	2.1	Sand Filters
Camp Dix	Camp Dix, N. J.	3.15	Additions—Std. trick. filter, Chlorination
Camp Edwards	Falmouth, Mass.	2.1	Two-stage bio-filters, & Sand Filt.
Fort Eustis	Ft. Eustis, Va.	1.12	Primary trt. Chlorination
Galveston Replacement Center	Hitchcock, Texas	0.7	Aero-filters, Chlorination
Camp Grant	Rockford, Illinois	0.7	Thru Rockford San. Sew. Sys.
Fort Huachuca	Ft. Huachuca, Ariz.	0.525	Primary trt. Chlorination
Camp Hulen	Palacios, Texas	0.84	Primary trt. Chlorination
Indiantown Gap Military Reservation	Annville, Penna.	1.54	Std. trick. filters, Chlorination
Fort Knox	Fort Knox, Ky.	3.5	Prelim. rough. filter & Sec. std. trick. filt.
Camp Lee	Petersburg, Va.	1.68	Primary trt. Chlorination
Camp Livingston	Alexandria, La.	1.54	Two-stage bio-filters
Camp McClellan	Camp McClellan, Ala.	1.54	Std. trick. filt. Chlorination
Macon Replacement Center	Macon, Georgia	1.26	Primary trt. Chlorination
March Field AA Firing Center	Riverside, Calif.	0.84	Single-stage bio-filter
Fort George G. Meade	Ft. Geo. G. Meade, Md.	2.1	Primary trt. Chlorination
Fort Monmouth	Ft. Monmouth, N. J.	0.70	Act. sludge & Chlorination
Nacimiento Replacement Center	Nacimiento, Calif.	1.75	Bio-filter
Camp Peay	Tullahoma, Tenn.	2.	Aero-filters, Chlorination
Pine Camp	Watertown, N. Y.	1.4	Primary trt. Sep. sludge digestion, Chlorination
Fort Riley	Ft. Riley, Kansas		Primary trt. Chlorination
Camp Jos. T. Robinson	Little Rock, Ark.	2.1	Std. trick. filters
San Diego Replacement Center	San Diego, Calif.	0.7	Aero-filt., Chlorination
Camp Merriam	San Luis Obispo, Calif.	1.4	Std. trick. filters, Chlorination
Seventh Corps Area Training Center	Newburg, Missouri	3.	Std. trick. filter
Camp Shelby	Hattiesburg, Miss.	4.2	Act. sludge Chlorination
Camp Stewart	Hinesville, Ga.	1.4	Primary trt. bio-filters, Sep. sludge digestion, Chlorination
Fort F. E. Warren	Cheyenne, Wyoming	0.525	Two-stage bio-filters, Chlorination
Fort Sill	Ft. Sill, Oklahoma	2.73	Prelim. rough. filter, Final std. trickling filter
Wilmington AA Firing Center	Wilmington, N. C.	1.4	Act. sludge, Chlorination
Camp Wolters	Camp Wolters, Texas	1.4	

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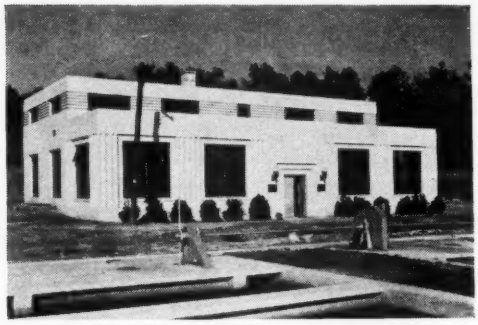


Shield for Sewer Tunnel

The contractor for an 8′ 6″ by 8′ 1½″ sewer in Pittsburgh designed a simple shield for driving his 1,420 ft. section through wet sandy clay and gravel. Hand methods, tried at first, progressed 24 ft. in three weeks; with the shield the progress was 283 ft. in 17 working days. The shield consists of two 10″ steel plate-and-angle ribs 4 ft. apart, connected near the bottom by longitudinal I-beams. The skin consists of two thicknesses of ¼″ plate extending 3½ ft. behind the rear rib and, at the top, 4 ft. in front of the front rib. The shield rides on 2 roller carriages on each side, which travel on tracks and are provided with jacks by which the shield can be raised or lowered. The shield is pushed forward by four 2½″ horizontal screw jacks framed into the front rib.[E 4]

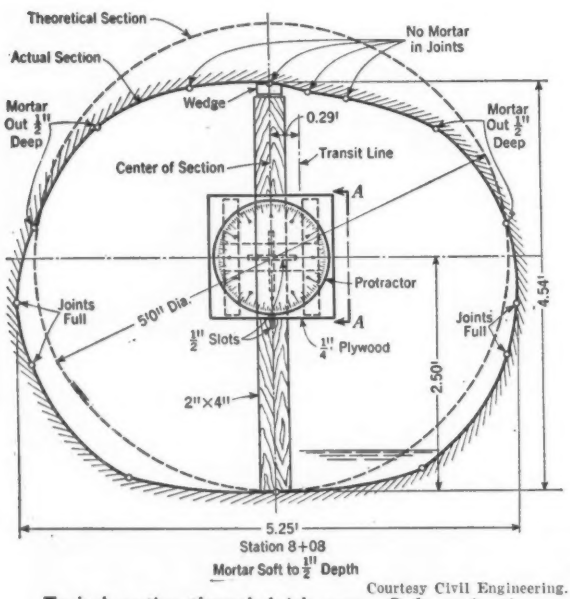
Surveying Old Sewers

Lousville, Ky., streets caved in at over 200 points following the 1937 flood in the Ohio river, and as this put a head of 30 to 40 ft. on the city's sewers, many of which were 38 to 90 years old, it was feared that many of them were damaged; and a complete survey was made of 25.2 miles of large brick and stone sewers and 3.2 miles of brick sewers less than 36″ diameter. The latter were inspected with mirrors only. The larger sewers were entered and cross sections taken at intervals of 100 ft. or less, alinement and profile taken with transit and level; also about 1,800 photographs were taken of bad places, and detailed descriptions of conditions such as missing bricks, bad joints, cracks, etc. Borings to determine ground conditions were taken from the surface at intervals of about 800 ft.

HOW TO FIND ORIGINAL ARTICLES. Key letter at end of each digest refers to name of publication listed in bibliography at end of this section. Numeral indicates title of article.

The work was done by two crews of 13 men each, working 8 hrs. a day for 24 weeks, each crew averaging 935 ft. of sewer per day. The air in the sewer was inspected and blowers operated a short time before the crew entered a sewer. The men were provided with rubber waders, raincoats, gloves, helmets, goggles, respirators, knee pads, etc.; and a 66c.p. storage battery cap lamp. There were only three or four minor accidents.

The sewers were found in much better condition than expected. In a few places the entire arch or side wall was gone. There were short stretches of sagging arches and walls bulging in or out, and others where the inner ring of brick had fallen out. Some mortar joints were gone, many were as good as when made. There was little erosion of the invert, even at steep grades; few transverse cracks but many longitudinal ones—some very wide along the center of the arch. At most points in the circular brick sewers the vertical diameter was less than the horizontal. The most common defect was found at hundreds of house connections, caused by poor workmanship in making them — bricks loose or missing, mortar gone, inlet pipes crushed, etc. A total of 1.19 miles of sewer was recommended for reconstruction, mostly egg-shaped brick and rectangular stone—only 800 ft. of circular sewer.[L 1]



Courtesy Civil Engineering.

Typical section through brick sewer. Deformation is representative.

Cathodic Tank Protection Patents

Cathodic protection of pipe lines and boilers is fairly old but has been used for water tanks only since August, 1936. The Electro Rust-Proofing Co., investigating at the U. S. Patent Office, found that the art of cathodic protection was so old that basic patents had long since expired and the only patents now obtainable would be on minor details in application. The only patent taken out is for attaching the ground wire on the riser of a certain type of elevated tank of which only a few exist.[X8]

Trickling Filter Capacities and Efficiency

Highly concentrated wastes, with B.O.D. up to 3,000 ppm, have been effectively treated by series filtration with a settling tank between the filters to remove agglomerated colloidal and finely suspended matters effected by a washable or coarse-grained primary filter.

With coarse-grain filters, short dosing cycles are conducive to a more uniform rate of discharge and materially increased efficiency; the more uniform the rate the more nearly the filter approaches its maximum efficiency for the load.

Emphasis in the past on nitrification properties of trickling filters was largely responsible for failure to recognize their tremendous capacity to remove B.O.D. constitutents by their agglomerating properties. Removal of 4,000 to 6,000 lb. of B.O.D. per acre-foot is feasible with fine-grain shallow washable or coarse-grain deep high-rate trickling filters combined with pre- and post-clarification; or such filters will reduce excessive fluctuations in concentration of wastes reaching final treatment—activated sludge or final trickling filter.[C 3]

Activated Sludge Plant Operation

The best aids to operation of activated sludge plants are control of dissolved oxygen in the aeration tanks, the sludge index, microscopic examination, and daily chemical analyses. Microscopic examinations help in anticipating difficulties connected with filamentous bacteria, which bacteria almost certainly accompany bulking at the Wards Island plant. Underaeration is indicated by presence of amoeba and arcella. Bulking is caused by continued high volatile matter content in the suspended solids in the primary tank effluent. Chlorine is most effective in combating bulking caused by microorganisms; but too little chlorine has no effect and too much causes breaking down of the floc. The sludge index as an indication of bulking is a relative figure differing at different plants. In

Indianapolis, the return sludge concentration is never allowed to exceed the sludge index expressed as percent solids; which practice does not permit retention of sludge in the settling tanks long enough to become damaged.[C 4]

Sludge Gas Utilization

With good temperature and pH control, yields of 0.6 to 1.5 cu. ft. of sludge gas per capita per day are common. The gas is being used for heating buildings and water; in laboratories for refrigeration, burners, water stills, ovens, sterilizers, muffle furnaces, etc., for incinerating screenings, skimmings, sludge and grit. For burning screenings, about 2 to 3 cu. ft. of gas is used per pound. At the end of 1940 the author listed 135 gas engines operated by sludge gas (not claimed to be a complete list), of which 67 were in Illinois, Indiana, Michigan and Wisconsin; and 9 had been installed between 1926 and 1934, 13 in 1935, 33 in 1936-7, 25 in 1938, and 55 in 1939-40. In some cases the investment in the installation is saved by eliminating or reducing electrical energy costs within two or three years. Of the 22,170 h.p. delivered by the engines listed, 19.6% is used for pumping, 35.5% for blowers and 44.9% for generators. "Our present noisy reciprocating sludge gas engines may yield to the smooth running gas turbine when the turbine is developed to a point of equal thermal efficiency."[C 5]

Chlorinated Copperas At Baltimore, Md.

Chlorinated copperas, used at Baltimore as a coagulant for conditioning digested sludge, was made at the plant at a cost of $26.67 per ton on the anhydrous basis in 1939 and much less in 1940—much less than the cost of ferric chloride; but vigilance is necessary to prevent escape of chlorine. Also copperas is highly corrosive and rubber or duriron is used for tanks, pipes, etc.; duriron is quite brittle and breaks easily. After the sludge has received the coagulant it should be filtered at once—holding it only 5 or 10 min. will result in a lower filter yield. Mechanical mixing of coagulant and sludge is preferable to compressed air.[C 7]

Garbage Disposal With Sewage

Dual disposal of garbage in sewage treatment plants has been tried experimentally since 1925, and plants are now operating, or about to begin, treating the entire garbage of six cities. But there is still much to be investigated concerning the effect of garbage on treatment processes, capacity requirements and quality of effluents. Trouble has been experienced with screens and grit chambers; there is considerable increase in floating solids and grease; a larger percentage of the solids passes out with the primary tank effluent, requiring increased oxidation capacity. Test results vary widely, indicating digestion in 4 to 64 days; gas production 8 to 13 cu. ft. per pound of volatile solids; methane content of the gas varied from 57% to 65%. The digested sludge drains readily.

Practically nothing is known about the cost. There must be thorough removal of bones and other large solids. What will it cost to dispose of the rubbish and ashes separately? What to provide the extra disposal plant capacity? On the other hand, the additional sludge gas from garbage is estimated to be worth $9,000 a year at Lansing and a minimum of $13,000 at Gary.[C 6]

Chemicals for Sewage Treatment

In general, rapid coagulation and compacting of sewage solids can be caused by destruction of their gel-like structure or by attacking the compounds responsible for holding the particles in suspension. Frequently both are done. But the relative quantities of substances causing the gel-like structure and those responsible for dispersion vary in different sewages and there is little probability that a simple, single chemical can effect high purification under all conditions. Coagulation should be used more generally than it is as an aid to biological processes, such as reducing the load on

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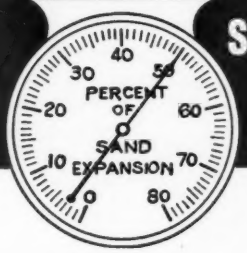

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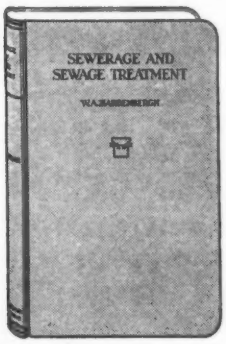

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activated sludge and trickling filter plants.

New chemical combinations are silicate-alum, sulfalcar, ferrigel, and copperas-sodium silicate. Tried at one plant, silicate-alum gave a higher removal of B.O.D. and suspended solids than ferric chloride or alum alone, with a very large floc; cost less than ferric chloride, slightly more than alum alone. Sulfalcar—$Al_2Cl_2\ SO_4(OH)_2$—goes readily into solution, produced a better and better-settling floc than alum, was especially effective with sewage containing laundry waste, gave high turbidity removal with a sparkling effluent, required no special equipment and cost 10 to 15% less per ton of suspended solids removed. The sludge was denser and compacted better. Ferrigel (a compound of ferric chloride and gelatine, glue or certain proteins) dissolves readily and acts rapidly; produces a large, strong, heavy, frequently ball-like floc which settles quickly; reduces the amount of ferric chloride necessary by about 40% and reduces cost; is effective over a pH range of 4.5 to 8.5; gives a dense, compact sludge which can be dewatered without further addition of chemicals and with a sparkling clear effluent; is stable indefinitely; completely clarifies sludge containing any amount of sulfur black or aniline dye wastes; is far less corrosive than ferric chloride. Copperas combined with sodium silicate (usually 3:1) at Chicago gave better results than alum-sodium silicate, ferric chloride or copperas alone, and at the lowest cost—$2.27 per million gallons as compared to $3.24 for ferric chloride. Using ferric chloride and lime, chlorinated copperas and lime, ferrisul or ferrisul and alum, the cost averages about $9.80 per million gallons for chemicals alone.[C 2]

Sedimentation at the Minneapolis-St. Paul Plant

The Twin City treatment plant consists of screen and grit chambers, flocculating and settling tanks, and effluent filters; the sludge being concentrated, vaccum filtered and incinerated. The entire plant is divided into two distinct and separately operated divisions. Each of the two flocculating tanks contains two 290 ft. channels and gives 24.5 min. detention at design flow. Each battery of settling tanks contains three units, each with three 290 ft. channels, giving 2 hrs. detention. The plant went into operation in July, 1938.

Operation up to January 1941 indicates that, with all units in operation, the following removals can reasonably be expected: By sedimentation only, 40 to 45% of B.O.D., 70 to 75% of suspended solids. By flocculation plus sedimentation, 45 to 50% and 75 to 80%, respectively. By these plus effluent filtration, 50 to 55% and 80 to 85%. By these plus use of chemicals in flocculation, 55 to 70% and 85 to 95%. When the detention period in the settling tanks was reduced to 1.5 hrs. the B.O.D. removal was 38% and the suspended solids 69%; when increased to 2.4 hr. the percentages rose to 42.9% and 74.4%, respectively, (more than 90% of the settleable solids).

Because of the length of settling tanks, the sludge removing equipment is operated continuously. Sludge is pumped three times a day, and by careful prevention of pumping too long, the average solids concentration of raw sludge as pumped has been held to a two-year average of 7.7, sometimes reaching 20%. Some difficulty is found in pumping such heavy sludge through 300 ft. suction lines and these are regularly blown back with plant effluent or compressed air. The sludge, especially after rains, contains large amounts of fine grit, reaching nearly 6,000 ppm of sewage. Some grit in the sludge aids vacuum filtering and reduces the amount of conditioning chemicals required.

Automatic skimming mechanisms in the settling tanks deposit scum in troughs which transport it to manholes, from which it was at first pumped to a dump and covered with incinerator ash; but pipes and pumps became coated with grease, the discharge pipe being reduced 90% in open area in 4 months, and an ejection method has been substituted for pumping. The skimming mechanism becomes frost-covered in cold weather and then hand skimming is employed.

The effluent filters are used only occasionally, chiefly because the settling tanks are much more effective than had been anticipated. The average results of 34 days' operation gave 28% removal of suspended solids, from 78 ppm to 56 ppm, when filtering at the rate of 2.5 gpm per sq. ft. The guarantee was 23½% removal with 80 ppm suspended solids in the filter influent, when filtering 3 gpm per sq. ft. [K 1]

Sludge Disposal at The Minneapolis-St. Paul Plant

Settled sludge at this plant, as delivered for conditioning during 21 months of operation, averaged 7.74% total solids (from 6.29 to 10.25), increased in concentration tanks to 9.12% of which 63.6% was volatile. This was conditioned by the use of lime and ferric chloride, about 11% and 2.7%, respectively, of the sewage solids at first, but reduced last year to 4.37% and 1.89% by careful control (using Bueckner funnel tests), agitation with large quantities of low-pressure air (better than high-pressure) and uniform distribution of chemicals. Presence of inert matter passing the grit chamber reduces amount of chemicals needed, thus effecting a saving of $100 a day. The vacuum filter cake has averaged 34.9% solids; has reached 39.1%. Reduction in amount of lime not only saved cost but greatly delayed lime-binding of filter cloths and deposits on screen wire. The filter rate averaged 4.87 lb. per sq. ft. for the entire period; reached 10 lb. at one time, but high rates increase operating costs and give an undesirably thick cake, and using more filters at lower rates was found more economical. With reduced lime dosage the economical life of filter cloth has increased to more

than 300 hr., often reaching 500 to 600 hr. Filter cloths are purchased locally at a fraction of the original cost and better made.

The multiple-hearth incinerators, instead of requiring $2,500 worth of fuel oil a month as expected, require none except for starting up; in fact, the heat produced by the sludge alone gave incinerator temperatures up to 2,200° F. instead of the 1,600° expected and caused considerable trouble until means were devised for by-passing hot air direct to the stock. It is possible this will be used to generate steam. The total power for operating the incinerator averages 17.3 kwh per ton of dry solids. The average B.t.u. per pound of combustible solids in the sludge was 10,800. The ash contained 1.6% volatile matter. The nominal capacity of each of the three incinerators was 60 tons of dry solids per 24 hr., but as much as 78.5 tons have been incinerated in one day with considerably higher hourly rates; the average actually consumed during a period of 18 mos. was 55.1 tons.[K 1]

Aluminum in Treatment Plants

Aluminum has been used for weir plates, sluice gates, collector troughs, diffuser plate holders, scum troughs and bar screens, both submerged and subject to sewage gases. In most cases (but not all) it has showed a marked resistance to corrosion, partly because the aluminum oxide which forms on all aluminum surfaces sticks to them tightly and forms a protective coating which is resistant to many chemicals, gases and solutions. However, strong alkalies dissolve aluminum oxide as well as the metal. Ammonia does not attack aluminum, either in gaseous or liquid form, nor does ammonium hydroxide. Hydrogen sulfide also has practically no effect upon it, nor has sulfuric acid. The common inorganic acids have slight effect on aluminum; but some of the organic acids, such as formic acid, are seriously corosive. Methane is harmless, but chlorine corrodes it; as do also solutions of sodium or potassium hydroxide. Sewage may contain almost any combination of chemicals and only a test with the sewage in question can determine how aluminum will react to it. Aluminum is used in various alloys, differing in corrosion resistance, in strength, etc., some are for casting, some for forging and some are heat treated to improve their physical characteristics.[H 7]

Garbage Collection a Municipality Function

The Ohio Court of Appeals holds, (City of Canton vs. Van Voorhis, 61 Ohio App. 419, 22 N. E. 2d 651) that a municipality ordinance providing that "no person other than the duly authorized employees of the city" shall collect and transport garbage over the streets of the municipality is not in conflict with the state statue regulating the matter but in compliance therewith, does not constitute a taking of property without due process, and is constitutional.

Bibliography of Sewerage Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

C *Sewage Works Journal*
November

1. Laboratory Instruction in Sewage Treatment. By G. M. Fair. Pp. 1033-1050.
2. Chemical Treatment of Sewage. By W. Rudolfs. Pp. 1051-1061.
3. The Role of the Trickling Filter in Sewage Purification. By M. Levine. Pp. 1062-1076.
4. New Developments in Activated Sludge Plant Operation. By G. P. Edwards. Pp. 1077-1086.
5. Sludge Gas Utilization. By R. E. Fuhrman. Pp. 1087-1097.
6. Dual Disposal—Where Does It Stand Today? By E. J. Cleary. Pp. 1098-1105.
7. Progress in the Conditioning of Sewage Sludge for Dewatering. By F. W. Jones. Pp. 1106-1115.
8. Inquiry Into Standards Proposed for Stream Cleanliness. By A. Wolman. Pp. 1116-1120.
9. Useful Nomographs in Sewage Treatment. By W. D. Hatfield and G. E. Phillips. Pp. 1121-1124.
10. A Slide Rule for Calculating Degree of Oxygen Saturation. By A. A. Hirsch. Pp. 1124-1126.
11. Twenty-fifth Annual Report of Division of Sewage Disposal, Schenectady, N. Y. Pp. 1126-1132.

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December 27

4. *p.* Short-Period Mesophilic Sludge Digestion at Davyhulme. By E. Ardern, C. Jepson and L. Klein. Pp. 337-338.

E *Engineering News-Record*
January 2

4. *c.* Simple Shield Drives Sewer Tunnel. By P. J. Mascaro. Pp. 34-35.
5. Design Factors for Dual Disposal. (Garbage and sewage). Pp. 38-39.

G *Water Works & Sewerage*
January

4. *p.* Solving the Problem of Billing for Sewage Disposal. By H. F. Smith. Pp. 21-24.
5. Sewerage Service Lines. By G. W. Seeley. Pp. 25-26.
6. Sewage Disposal System of Gowanda, N. Y., State Hospital. By W. Edwards. Pp. 27-29.
7. Waste Control Laboratory of the Atlantic Refining Co. By W. B. Hart. Pp. 30-31.

H *Sewage Works Engineering*
January

7. Aluminum Tested in Sewage Works. By R. C. Wilson. Pp. 10-12.
8. Imhoff Tank Replaces Cesspools at Canisteo, N. Y. By B. Scanlon. Pp. 13-15.
9. State Hospital Uses Modern Plant. By W. Edwards. Pp. 16-17.
10. *p.* The Value of Sewage Gas. By M. W. Tatlock. Pp. 18-19, 22.
11. Effluent for Dakota Alfalfa. By A. A. Chenoweth. Pp. 23-24.

J *American City*
January

3. Sewage Treatment Plant for Meriden, Conn. By A. J. Burdoin. Pp. 50-52, 77.
4. Digester Gas Engine at Escanaba, Mich. By J. T. Norgaard. Pp. 60-62.

K *Proceedings, American Soc. of Civil Engineers*
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1. Experiences in Operating a Chemical-Mechanical Sewage Treatment Plant. (Minneapolis - St. Paul). By G. J. Schroepfer. Pp. 61-92.

L *Civil Engineering*
January

1. Technique for a Survey of Old Sewers. By C. F. Johnson. Pp. 27-30.

Canadian Engineer
December

3. Sewage Plant at Stratford, Ont. By W. H. Riehl. P. 22.

P *Public Works*
January

4. Rotary Distributors of Sewage for Sand Filters. By H. A. Stepleton. Pp. 11-12.
5. *n.* Dust Storms Clog Trickling Filters. P. 12.
6. The Calendar, the Clock and Sewage Samples. By W. F. Crohen. Pp. 20-22, 36.
7. *n.* Village of 900 Completes Sewer System. Pp. 34-35.
8. Water and Sewer Systems at Camp Ord Military Reservation. Pp. 40-42.

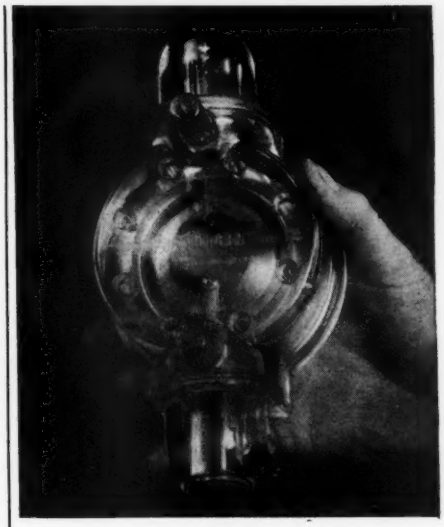

Fig. 1

DO YOU WANT TO "SEE-THRU" YOUR CHLOR-O-FEEDER?

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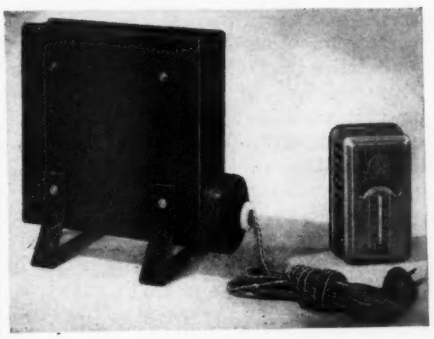

Fig. 2

WINTER IS HERE!

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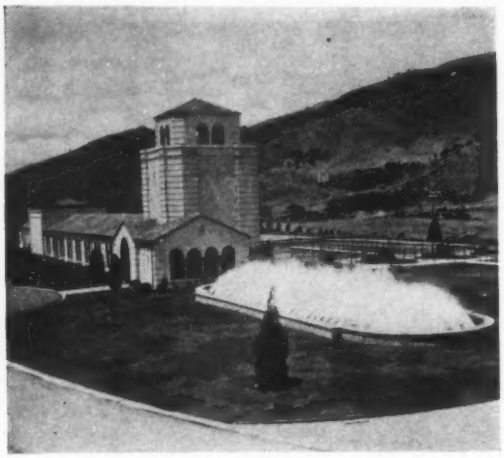


The Waterworks Digest

Abstracts of the main features of all important articles dealing with waterworks and water purification that appeared in the previous month's periodicals.

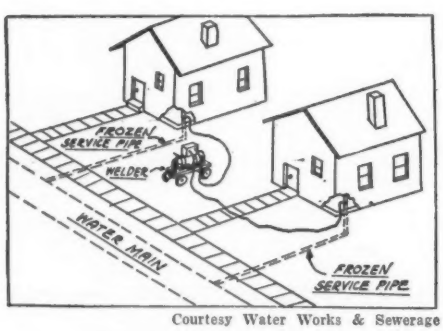
HOW TO FIND ORIGINAL ARTICLES. Key letter at end of each digest refers to name of publication listed in bibliography at end of this section. Numeral indicates title of article.

Roof for a 4-Acre Reservoir

A 4-acre reservoir of irregular shape in Ventura, Calif., about 340 x 565 ft. and 18 ft. deep, was recently covered with a roof consisting of precast concrete columns, girders and beams supporting a corrugated metal roof. No live load is provided for. The 515 columns rest on 3 ft. square piers supported by the concrete floor. The total roof area is divided into four units by two expansion joints at right angles to each other. Concrete purlins have 2 x 3 in. redwood strips cast in their upper edge to serve as nailing pieces for the galvanized metal roofing. After completion, the entire exterior surface was given a spray coat of gray cement primer paint followed by a spray coat of aluminum in a bituminous vehicle.[E 3]

Thawing Services Electrically

Small portable transformers connected to the house wires are limited in use to slow thawing of short lines. Those connected to street lines should have the lowest voltage available on the secondary, to minimize hazard. The gasoline engine-driven welder is the most flexible thawing unit available; its voltage should be between 30 and 60, and amperage limited to 400 amp. if copper services are to be thawed, otherwise to 200 amp. to save cost. The current rates suggested as most desirable are 300 to 400 amp. for copper, 200 for steel or wrought iron, 75 to 150 for lead and cast iron. Lead melts at 625°, copper at 1900°, iron and steel at 2,500°-2,800°. The time required to thaw a service is inversely proportional to the square of the amperage used, but time is secondary to safety. Be sure of good electrical contacts; that the wires from the source of energy are adequate; that you know the material used in the service and adjust the current accordingly; be sure no current feeds into the gas service—ascertainable by feeling gas meter couplings for heat.[G 7]



Courtesy Water Works & Sewerage

Suggested thawing hook-up.

Polluted Well Water

There are in Maryland 110 ground water supplies serving 115,000 population, of which 18 are chlorinated. Over 32% of the waterbound typhoid fever outbreaks in the United States between 1920 and 1936 occurred where underground water was used. In January, 1940, of 15,000 public water supplies, 7,500 were from wells and 1,700 of these were chlorinated. Pollution of well water is caused by surface water entering the wells, as where well casing is imperfectly sealed to the rock in which it terminates, where ground water enters from a flooded well pit, or where the well casing is corroded. Or pollution may be drawn into the suction line between well and pump. Where air conditioning water is returned to the ground, it may be desirable to chlorinate it both because it may have been polluted and also to prevent the clogging of the underground soil by slimes that unchlorinated water has been found to cause.[X9]

Break-Point Experiences Recently

By chlorination just beyond the break-point, upper Sandusky, O., maintained residuals in open reservoirs for periods up to 20 days; iron bacteria were held in check in California wells; Miami, Fla. reduced the color of the water (in some cases the color has increased at the break-point, but this was due to formation of color floc that is easily removed). It has been established by 1939-1940 studies, that, when combining ammonia with chlorine, when the ratio of ammonia to chlorine approaches 1:10, oxidation of the ammonia begins, usually resulting in loss of ammonia and reduction in residual, this action taking place most rapidly at pH above 7.0. Presence of albuminoid ammonia and organic material in general tends to modify this ratio. Copperas has been used as a dechlorinating agent at Reading, Pa. Apparatus is now available for automatically applying chlorine in such amounts as to maintain a constant residual with varying flow and demand, using an electric cell. Jester warns against adopting superchlorination without first making comprehensive studies with superchlorination on the water supply in question or without proper laboratory control and facilities for rapid and effective dechlorination.[X10]

Anthrafilt In Filters

At Newport News, Va., use of anthrafilt on top of a sand filter unit, one-third the former and two-thirds sand, was so successful that the entire plant is being changed to this, using anthrafilt of 0.72 m m size. The coal acts as a roughing filter and a coating forms on top of the sand, which necessitates special filter washing procedure. The combination filter ran for 56 hours between washes while plain sand ran only 7 to 12 hours, during a recent algae period; the two running an average of 30 and 70 hrs. respectively when algae were absent.[X3]

Superchlorination And Dechlorination

Superchlorination consists of using a dose of chlorine slightly higher than the amount required to satisfy the maximum chlorine demand of the water. This will produce the maximum oxidation or destruction of taste and odor which can be accomplished with chlorine, and should also result in a high degree of bacterial disinfection. It must ordinarily be followed by dechlorination, as by sufficient detention time in coagulation and sedimentation basins. If only a small amount

remains, addition of ammonia will hold this and prevent chlorine taste. Activated carbon applied for taste control will partially remove residual chlorine. Granulated activated carbon filters dechlorinate efficiently and almost automatically. Sulfur dioxide provides an easily regulated method of dechlorination.[X5]

Cleaning Corroded Well Screens With Acid

Parkersburg, W. Va., obtains its supply from 18 wells of the gravel packed type, 36" to 38" outside casing and 18" inside casing and screens. In ten years the capacity fell from 6 mgd to about 3 mgd and this was found to be due to corrosion of the screens. The screen capacity was restored as follows: Ten carboys of muriatic acid (about enough to fill the screen) were poured into the well through a 3" pipe. Then steam was applied, through a small pipe which extended to within about 12" of the bottom of the well, for a period of 4 to 6 hr., warming and agitating the acid. About 24 hr. later from 1,000 to 1,200 lb. of soda ash was poured into the well and steam applied as before. After another 24 hr. a swab and sand bailer pump were used to remove the loosened particles, and the pump replaced and put into service. The combined production was increased almost 60%; that of some wells over 300%.[A 18]

Chemical Standards Of Potable Water

It is not possible to set up any standards of chemical characteristics that will suffice to judge all supplies, but approximations can be made applying only to restricted areas. The following shows the normal range for *average conditions in eastern Pennsylvania.*[X2]

GUIDE TO INTERPRETATION AND USE OF SANITARY CHEMICAL ANALYSIS OF WATER

BASED ON AVERAGE CONDITIONS IN PENNSYLVANIA

Results expressed—where possible—in parts per million

	Good	*Fair*	*Suspicious*	*Average Sewage Results for Comparison*
Color	0	0 to 5	5 and up	0 up
Odor	None	Negligible	Noticeable	Strong
Turbidity	0 to 0.2	0.2 to 1.0	1.0 and up	50 and up
Alkalinity	5 to 100	5 to 125	Below 5—above 125	50 to 150
Hardness	5 to 50	50 to 100	Below 5—above 100	
Carbon Dioxide	1 to 5	5 to 10	10 and up	
pH	6.0 to 7.2	6.0 to 7.5	Below 6.0—above 7.5	5.0 to 8.0
Total Solids	10 to 50	10 to 100	100 and up	200 to 1500
Dissolved Solids	100% to 96	96% to 90	90% and under	75% to 25
Suspended Solids	0 to 4%	4 to 10%	10% and up	25% to 75
Volatile	0 to 10%	10 to 20%	20% and up	25% to 75
Fixed	100% to 90	90% to 80	80% and under	75% to 25
Chlorides	1 to 2	2 to 5	5 and up	20 to 150
Oxygen Consumed	0 to 0.1	0.1 to 1.5	1.5 and up	25 to 125
Nitrogen:				
As ammonia nit.	.002 to .020	.020 to .050	.050 and up	5.0 to 50.0
As albuminoid nit.	.010 to .050	.050 to .100	.100 and up	7.0 to 35.0
As nitrites	.000 to .001	.001 to .003	.003 and up	.0 to .20
As nitrates	.00 to .10	.10 to .50	.50 and up	.0 to 10.0
Iron	0.0 to 0.1	0.1 to 0.3	0.3 and up	
Manganese	0.0 to 0.1	0.1 to 0.2	0.2 and up	
Dissolved Oxygen	100%	90 to 100%	90% and under	0 to 100%

in % saturation (Saturation at 32° F.—14 p.p.m.; at 70°—8 p.p.m.)

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Flow in Large Pipes

Modern methods of constructing and lining water pipe introduce new conditions affecting flow capacity. Partly for this cause, the Chezy formula with Kutter's coefficient has given place in general use to the Williams-Hazen and the author recommends substituting the Mills formula for this. A comparison, reducing all to the formula for H in the general form $H=K\frac{V^2}{D}$ (the Chezy formula), gives exponents for V and D as follows: Chezy: for V, 2; for D, 1. Williams-Hazen: for V, 1.852; for D, 1.167. Mills: for V, 2; for D, 1.25. Scobey: for V, 1.9; for D, 1.1.

Studies, chiefly of large pipe lines in northern New Jersey, led to other conclusions, among them that riveted steel pipes have shown serious loss in carrying capacity in the past, much of it due to disintegration of the pipe coating; but improvements in making smooth bore pipes and in making and applying coatings, both bituminous and cement, have greatly increased carrying capacities. In the case of modern pipes with demonstrated durability of coating or interior surface, age is far less important than formerly in its effect on carrying capacity; cement or concrete surfaces may even improve with age. Old pipes may be relined and capacity increased, to above the original in many cases, and may be expected to continue to deliver at the increased rate. Relining is an economic factor that cannot be ignored.

Quality of water has had much to do with reduction in capacity, but need not cause concern for pipes having reasonably permanent interior surfaces. Concrete pipe, or steel pipe with cement mortar lining, is little affected by quality of water except such as is very aggressive in taking minerals into solution. Higher chlorine residuals probably inhibit growths and accumulations in pipe lines.[A 11]

Filter Bottoms And Filter Washing

Most filter operators allow a filter to run until the loss of head increases to the maximum and the rate begins to decrease. In some plants coagulation may become so weak that coagulated matter passes through the filter before the loss of head equals the maximum ordinarily used, and these should be equipped with floc detectors and the filters washed when coaulated matter begins to pass through them, regardless of the loss of head.

No filter bottom that includes gravel will insure freedom from mounding or ridging of the gravel. Many advise rescreening the filter material occasionally or even frequently, rather than reconstruct the bottom of the filter; in fact, some bottoms are so well cemented in place that reconstructing the underdrainage would be impracticable. No one has produced a filter bottom which has remained in good condition while handling all types of water. Even uniform distribution of wash water does not eliminate filter bed troubles. The use of coarser filtering material and faster rates of filtration has reached the point where it is approaching too close to the limits to insure excellent results with all qualities of water. Poor filter performance may be due to poor design, too coarse or too fine sand, poor conditioning of water, improper operation, lack of knowledge of filtration essentials, or failure to exercise care or judgment.[B 2]

Locating Cross-Connections

The existence and location of cross-connections between two supplies can be determined simply by measuring the electrical resistance in a wire connecting the two. If the resistance exceeds 0.3 ohm there is probably no cross-connection and if there is a cross-connection the resistance usually is only 0.1 to 0.2 ohm; as the connection of wire to pipe is moved toward the cross-connection the resistance decreases. The equipment used may be 4 dry cell batteries connected in multiple, and a 30-ampere shunt and millivoltmeter. Cost $25 to $50.[A3]

Bibliography of Waterworks Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

A *Journal, American Water Works Ass'n.*
January

11. Trends in Coefficients of Large Pressure Pipes. By C. H. Capen. Pp. 1-83.
12. The Water Superintendent and the Elected Official. By F. D. Livermore. Pp. 84-90.
13. The Superintendent of Tomorrow. By H. V. Pedersen. Pp. 91-96.
14. Effective Management Under Municipal Ownership. By L. A. Smith. Pp. 97-102.
15. What Water Softening Would Do for Wisconsin Cities. By L. R. Howson. Pp. 103-120.
16. Public Water Supply in the Civil Defense Program. By H. E. Jordan. Pp. 121-137.
17. Control of Water Well Drilling. By L. S. Finch. Pp. 138-144.
18. Cleaning Wells in Parkersburg, W. Va. By G. Underwood. Pp. 145-146.
19. The Bacterial Corrosion of Iron and Steel. By T. D. Beckwith. Pp. 147-167.
20. Control of Iron Bacteria by Super-Chlorination. By E. B. Carroll. Pp. 168-170.

B *Journal, New England Water Works Ass'n.*
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2. Filter Operation and Maintenance. By J. R. Baylis. Pp. 393-427.
3. Promoting Taxpayers' Interest in Their Water Supply. By C. Schwarzler. Pp. 428-438.
4. Problems in the Management of Municipal Water Works. By L. R. Howson. Pp. 439-446.
5. Accelerated Clarification. By F. J. Lammers. Pp. 447-455.
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November 29

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4. Meter Practice at Grand Rapids. Pp. 53-54.

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8. Treatment Plant Practices (at Niles, O.). By N. N. Wolpert. Pp. 10-13.
9. Flushing Hydrants Requires Tact and Good Judgment. By H. T. Hotchkiss. Pp. 19, 33.
10. *c.* Laying Distribution Mains. Pp. 24-25.

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11. Providence, R. I., Improves Its Treatment Plant. By P. J. Hoton, Jr. Pp. 60-64.
12. Treatment Plant Practices at Youngstown, O. By N. N. Wolpert. Pp. 65-68.
13. Diesels Show Savings in Two Old Pumping Stations. By H. T. Gidley. Pp. 69-71.
14. *c.* Laying Distribution Mains. Pp. 77-78.
15. How Rochester, N. Y., Disinfected Mains Accidentally Polluted. Pp. 83-84.

G *Water Works & Sewerage*
January

5. Progress of the Year in Water Supply and Purification. By N. J. Howard. Pp. 1-11.
6. Illuminating Milwaukee's Water Purification Plant. By A. Ryndus. Pp. 13-17.
7. Thawing Service Lines and Small Mains Electrically. By F. C. Amsbary. Pp. 18-20.
8. Superchlorination Eliminates Iron Bacteria. By E. B. Carroll. Pp. 36-37.

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V *Journal, Maine Water Utilities Ass'n.*
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1. Water Supply in the Town of Mexico, Me. By H. McInness. Pp. 3-9.

X *Journal, Pennsylvania Water Works Operators Assn.*
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2. Chemical Analyses of Water and Their Interpretation. By J. J. Shank. Pp. 63-79.
3. Suggestions for the Small Plant Operator. By W. A. Hardenbergh. Pp. 80-94.
4. Water Analysis in the State Laboratories. By V. Nisbet and J. C. Rhodes. Pp. 95-103.
5. Pre-, Post-, Super- and De-Chlorination. By H. A. Faber. Pp. 104-109.
6. Sodium Hexametaphosphate as an Aid in the Control of Corrosion. By O. Rice. Pp. 110-146.
7. Methods and Results of Water Main Cleaning. By J. A. Frank. Pp. 147-151.
8. Corrosion of Steel Water Storage Tanks and Prevention by the Cathodic System. By G. W. Knight. Pp. 152-160.

X *Proceedings, Maryland-Delaware Water & Sewerage Ass'n.*
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9. Disinfection of Ground Water Supplies. By G. L. Hall. Pp. 1-8. By R. C. Clement. Pp. 8-10.
10. Recent Advances in the Chlorination of Water. By A. E. Griffin. Pp. 45-50. By H. A. Faber. Pp. 50-55. By J. M. Jester. Pp. 55-60.
11. Keeping Iron In or Out of Solution. By L. R. Caplan. Pp. 98-110. By J. G. Patrick. Pp. 110-114. By L. L. Hedgepeth. Pp. 114-115.
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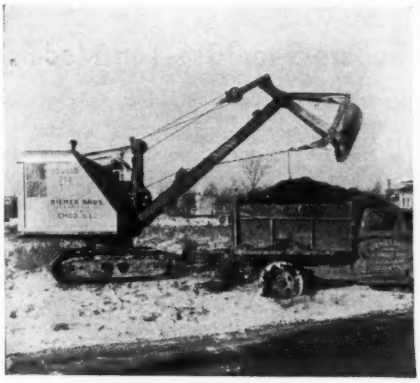
Keeping Up With New Equipment

The New Osgood Type 20 ½-Yard Shovel

The Osgood Company, Marion, Ohio, has brought out a new Type 20, Model 200, ½ cu. yd. machine, embodying the latest features of modern engineering design. It is claimed to be a rugged and powerful machine, with special attention given to straight-line delivery of power, and simplicity of operation. Unnecessary parts have been eliminated, and the design simplified and balanced. It is convertible to any type of service, such as crawler, standard truck, and Osgood special wheel mounting. It is powered with either gasoline or diesel engine. Power is taken direct from the engine to the swing and travel shaft by a triple-strand roller chain, fully enclosed, and equipped with sight feed lubrication.



Osgood ½-yard shovel.

On the upper deck there are only two cross shafts; on the lower frame, only one. The countershaft has been eliminated. The two horizontal shafts are mounted in roller bearings, carried in the side frames. The main deck casting is of one-piece construction, with all machinery mounted on machined pads.

Clutches and brakes on the swing and travel shaft are of large diameter, wide faced, and controlled by a hand lever at the operator's position. Clutches and brakes on the drum shaft are controlled by Osgood "Servo" mechanism. All vertical shafts: reversing, swing, intermediate, and travel shafts, are recessed in the deck, enclosed, keeping out all dirt and foreign matter. The boom hoist is a separate unit, mounted in the left-hand side frame. It has a self-locking steel worm and bronze worm wheel.

For shovel service, the crowding sprocket is mounted on the right hand drum, which is the hoisting drum for crane, dragline, and clamshell operations. For quick and easy change from shovel to crane, etc., the crowding sprocket used for shovel, and the lagging used for the other types of service, are mounted on the drum in two pieces, eliminating the necessity of removing the drum in making the change. The cab is of the latest streamlined design, giving all-weather protection and full operating vision.

For specifications and details, write to this publication, or The Osgood Company, Marion, Ohio.

Fairbanks-Morse New Angleflow Pump Bulletin

A 16-page Bulletin (No. 5710), illustrating and describing their new line of Angleflow Pumps in both vertical and horizontal types, has just been released by Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago, Ill. This will be of particular interest to consulting engineers and others engaged in the design, construction, operation and maintenance of large-capacity pumping operations, such as land drainage, flood control, irrigation, storm water disposal, municipal pumping, excavation unwatering, cofferdams, etc.

This Fairbanks-Morse Angleflow Pump line combines the advantages of both the radial flow Francis runner type of centrifugal pump and the axial flow diffuser type of propeller pump, being technically a design about half-way between. The hydraulic stream flow through the impeller is at an angle to the axis of rotation (center of pump shaft) which gives the pump its name.

A volute is used for the velocity recovery, therefore no diffusers such as are employed in propeller pumps are necessary. This makes the unit suitable for many applications where there is some flexible trash such as dirt, silt, sticks or stones or other foreign matter in the water being handled. It also eliminates the shearing effect which is always present between the back side of the rotating propeller blade and the front side of the stationary diffuser blade in the propeller type of pump.

Fairbanks-Morse angleflow pump.

Both vertical shaft and horizontal shaft types of Angleflow pumps are provided in standard sizes up to 54″ discharge and in special larger sizes, depending upon the job requirement.

These units have two sets of double and replaceable wearing rings on an advanced type of enclosed impeller, very large and adequate shaft and bearings, and streamlined water passages that are derived from extensive research and field experience. This type of pump is suitable for those large-capacity installations in the lower heads where continuous trouble-free service at low power cost and upkeep cost is more important than the mere pump plant cost.

J. G. Pollard pipe locater.

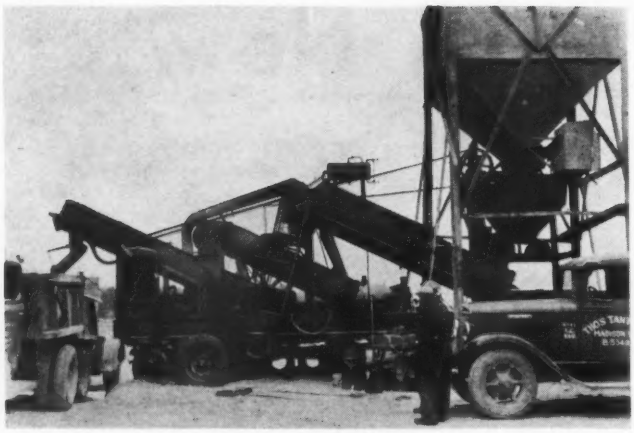
---

3 Pipe Finders in 1

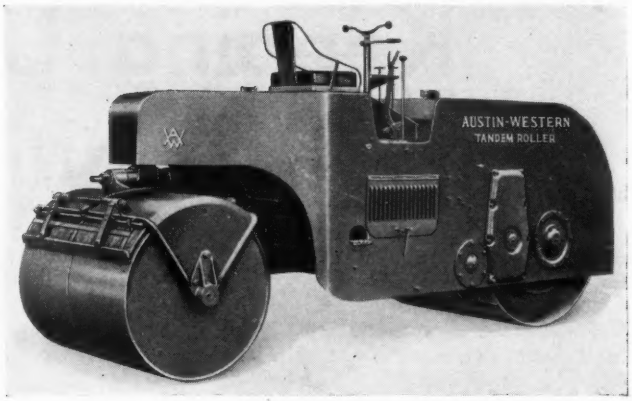
This finder is conductive, inductive and has a radio balance operation. A special individual conductive transmitter is incorporated with the M-Scope inductive transmitter. A 5-step power selector permits adaptation to any problem. Two visual indicators double the efficiency. A large 4½″ meter indicator provides accurate centering and determination of depth, and an easy-to-read 2″ meter indicator permits quick tracing of pipes.

All controls are properly marked by individual name plates. Gradual volume control meets individual ear-sensitivity.

It is contained in a sturdy protective leatherette carrying case with two compartments for all accessories. Joseph G. Pollard Co., 142 Ashland Place, Brooklyn, N. Y., will be glad to send complete description.



Cleaver-Brooks asphalt mixing plant.



New Austin-Western tandem roller.

Cleaver Asphalt Mixing Plant

Cleaver-Brooks Company of Milwaukee, pioneer builders of tank car heating equipment, after several years of research and actual field experience is now offering aggregate drying equipment and asphalt mixing plants for both portable and stationary operation by counties, small cities and State highway departments. The asphalt mixing plant produces a high-type plant mix in moderate quantities at low cost.

The plant shown in the photograph is ruggedly mounted on semi-trailer and is completely self-contained, i.e., dryers, conditioner and mixer. The dryers are equipped with oil burners identical to those employed on Cleaver heaters and boosters. Aggregate is fed to the dryers by means of an apron feeder with positive and accurate control. After the material has been thoroughly dried it is immediately run through the "conditioner" where it is aerated and cooled. Bitumen is then added and the mixing process is started. The percentage of bitumen in the mix is controlled to within one-tenth of one percent. By a specially designed method the aggregate and bitumen are thoroughly and completely mixed.

Since the plant is self-contained, it requires no setting up or taking down operations and the production of mix can be started within a few minutes after it arrives on the job. It is powered by a sixty horsepower Waukesha engine and is equipped with a Kinney asphalt pump operated by a Briggs & Stratton engine. Operation of the plant is simple and can be handled by one man easily.

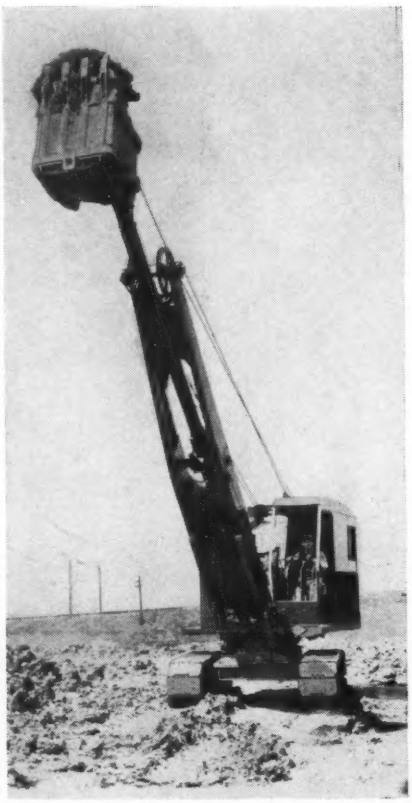
Aggregate drying equipment as separate units are also being offered by Cleaver-Brooks.

Preventing Uneven Wear of Manhole Covers

Tapex Manufacturing Company of Mamaroneck, N. Y., is advocating a new application of the ancient adage that "an ounce of prevention is worth a pound of cure." In other words, instead of waiting until manhole frames and covers become worn and consequently noisy, they suggest recessing all new manhole cover frames when they are installed sufficiently to permit insertion of manhole cushions. The cushion would then absorb the grinding that otherwise is apt to cause uneven wear as the cover turns under impact of traffic.

A Shovel, Dragline, Crane and Pull Shovel

The SUPER-PAYMASTER, a ¾ yard combination shovel, dragline, crane and pull shovel, recently developed by the Lima Locomotive Works, Incorporated, Shovel and Crane Division, Lima, Ohio, is claimed to be a major contribution to the efficiency and profitable operation of the earth moving and material handling industry. Its design embodies the same time-tested features that made its predecessor, the PAY-MASTER, so unusually popular with its many users. When equipped as a clamshell or dragline, capacity depends upon length of boom and material to be handled. When equipped as a crane, it has a 13-ton capacity. As a shovel it is equipped with an 18′ boom and 15′ dipper handle. It is exceptionally fast with ample strength to give steady dependable service in all kinds of work. Many new features which are worth consideration are found in its design.



A ¾-yard "Super Paymaster" shovel.

New Variable-Weight Tandem Rollers 5 to 10½-Ton Models

Austin-Western Road Machinery Co.

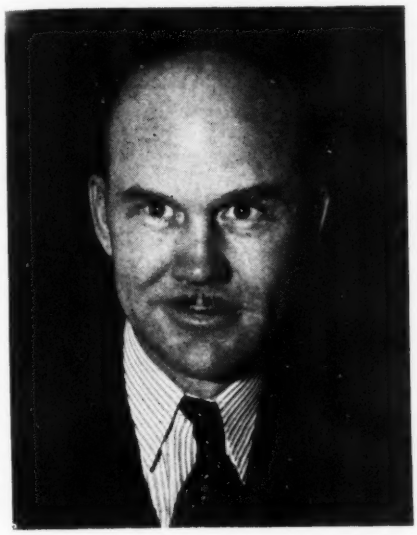
What the manufacturers claim to be the finest operating tandem rollers in a series of models introduced since 1913 have just been announced by The Austin-Western Road Machinery Co., Aurora, Illinois. They are built for general rolling use and precision work and include a number of improvements and refinements in design to obtain exceptionally smooth and steady performance. The weights of the front and rear rolls can be increased by adding water to meet a wide variation of roller requirements ranging from 133 to 301 lbs. per lineal inch.

Among the operating advantages of these two entirely new units is better visibility to see closer to curbs; more convenient controls, with reversing clutch lever mounted on steering column (for easier and less tiring clutch engagement); effortless hydraulic steer; a lower center of gravity to prevent sway; less frame over-hang to permit rolling closer to curbs; more ground clearance under side plates to clear higher curbs; more stability because box-shape construction resists twisting strains; balance of engine and final drive parts to provide uniform weight distribution across entire rear roll and good accessibility for reaching or servicing moving parts, hydraulic pump, strainer, etc.

Mechanical features include: All welded, two-piece front rolls and rear roll, all of which are mounted on anti-friction bearings; front fork with horizontal kingpin mounted on widely-spaced bearings and large diameter,

vertical kingpost mounted in Timken bearings for maximum stability and smooth steerability; gasoline or diesel power; two-speed forward and two-speed reverse type transmission with heat-treated, alloy steel gears and shafts and anti-friction bearings throughout; a master clutch between engine and transmission, controlled by foot pedal, and two, double-disc reversing clutches.

Full information will be furnished on request.



Miles D. Catton, Manager of New Portland Cement Bureau.

Portland Cement Association Forms Soil-Cement Bureau

In recognition of the fact that soil-cement mixtures have become of major importance in the construction field, particularly in their use for light-traffic roads, streets, at airports and roads at Army camps, the Portland Cement Association, whose headquarters are in Chicago, announces the creation of the Soil-Cement Bureau. The new bureau can thus give added service to highway, airport and military engineers on all details of soil-cement testing, construction, specifications and use.

Miles D. Catton, who has been in active charge of soil-cement development since the Association started research in this field seven years ago, has been named the manager of the new bureau.

The Soil-Cement Bureau will function in a manner comparable to the other general office bureaus, and will be responsible for direction of promotion, testing and supervision of construction of soil-cement mixtures.

The association says since the first project was started in South Carolina in 1935, soil-cement construction has found its way into all sections of this country. As of January 1, 1941, 242 projects in 35 states were either built or under construction.

The most recent spectacular soil-cement project is found in Texas where the State Highway Department has built a continuous stretch of 46 miles through the famous King ranch.

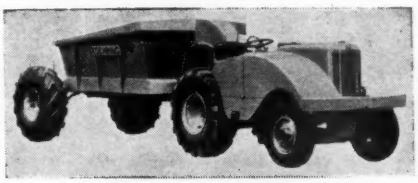
Giant 8-Yd. Truck Mixers Built by Jaeger

The world's largest transit concrete mixers, a fleet of giant units that provide 8 cubic yard payload (equal to 16 tons of mixed concrete) are being put in service by The Colonial Sand & Stone Co., Inc. of New York City. They were developed by The Jaeger Machine Co., Columbus, Ohio, based on the highly successful "New York Special," 5½ yd. model, over 150 of which are being operated in New York City.

The complete unit, mounted on a six-wheel truck powered with a 150 h. p. diesel engine, stands 12 ft. high, is approximately 26 feet long and weighs 31½ tons when fully loaded. The mixing drum is driven direct from the truck engine and, by means of Jaeger vacuum control, the operator is able to start and stop the 16-ton load of the revolving drum merely by flipping a valve at the steering wheel.

Drum is equipped with two top charging doors. After enough material to produce five cubic yards of concrete is received through the first door, the machine then moves forward to bring the second door under the charging hopper where the remainder of the eight-yard batch is received.

Total capacity of the water tank is 325 gallons, consisting of mix, flush and tempering water, all of which are controlled from a single "Uni-Valve" panel on the tank. Special aluminum accuracy chamber encloses syphon shut-off in tank so that accuracy of water measurement cannot be affected by splashing or surging of main body of water.



Koehring trail-dump.

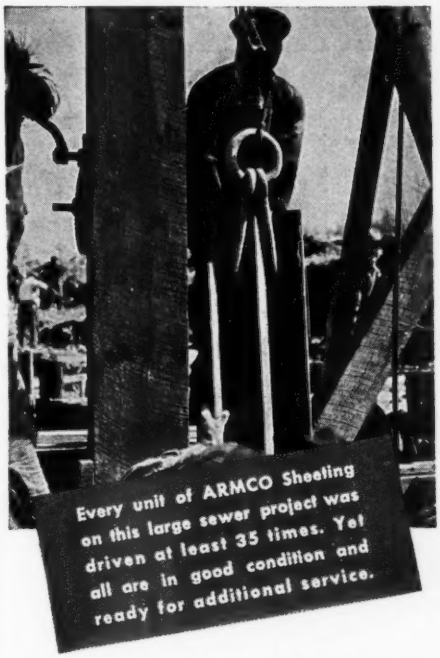
A New Size Trail-Dump

Koehring has added another new size Trail-Dump to its line of hauling equipment. This latest model has a capacity of 12 cubic yards, giving a total of three sizes, 8, 10 and 12 cubic yards. With the increased capacity, Koehring has increased the strength of the body, improved the "automatic hand" winding mechanism and made such other changes as were necessary for the increased load. A' General Motors two-cycle diesel engine furnishes steady and dependable power. Gasoline engine power is also available.

Approximately one year of field service on contractors' jobs has placed this machine beyond the experimental stage and it is now released for general sale.

Write Koehring Co., 3026 W. Concordia Ave., Milwaukee, Wisconsin, for specifications.

DRIVEN 35 TIMES ...STILL A-1 SHEETING


Every unit of ARMCO Sheeting on this large sewer project was driven at least 35 times. Yet all are in good condition and ready for additional service.

Many contractors and engineers know from experience that ARMCO Sheeting has what it takes for repeat performances. It is readily pulled and can be used again and again.

Naturally this high salvage value means low material costs on trenches, cofferdams, foundations and similar works. You need less sheeting for big jobs. On smaller projects you save by moving ARMCO Sheeting from job to job, thus eliminating the expense of new material. Between jobs the nestable units take up little storage space.

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PEOPLE . . . Here and There

Road Builders Meet In New York City

In what was to many a brand new type of American Road Builders' Association meeting, the 38th annual convention of the organization was held in New York January 27-31.

John M. Carmody, Administrator of the Federal Works Agency, speaking from Washington, called for a $230,000,000.00 road construction program for national defense. The message said that Army, Navy and defense industries are in vital need of 4,000 miles of road within and approaching military reservations and industrial sites.

"Nor is this the end," Mr. Carmody declared. "Daily we are building new Army camps, Navy establishments and defense industrial sites. At present there are 175 camps certified for defense roads, but this figure is certain to increase. Moreover, the access roads to these camps and industrial sites are being delayed, and they represent more than half and about three-quarters of the total cost of the urgent defense roads."

Mr. Carmody stated that the proposed $230,000,000 program has been certified as necessary to national defense by the War and Navy Departments and the advisory commission to the Council of National Defense.

Another aspect of the program was described by Mr. Carmody in the case of the 75,000 miles of long distance routes designated as "the strategic networks."

"These highways have many weaknesses," he said. "Four thousand miles of them are less than eighteen feet wide, 14,000 more are deficient in surface strength, 24,000 of their bridges are deficient in strength and 500 more bridges are not wide enough."

He felt these can be brought up to standard at a fairly reasonable cost gradually.

Association Calls On Congress to Give Needed Funds

At the final session the Association pledged the utmost aid of its 30,000 members and called on Congress for funds and a national program to build strategic highways up to military needs. At previous sessions during the five-day meeting at the Hotel Pennsylvania the Association had heard estimates that $1,230,000,000 must be spent on improving the United States military road network.

The directors of the Association voted the following resolutions without including any cost specifications: "To ask Congress to take prompt action on appropriations in a special program to eliminate bottle-necks and weak spots in the military highway system.

"To establish a Federal fund paying the entire cost in constructing access roads to military and naval cantonments.

"To appropriate payments for serious damage to local, state and Federal highways resulting from Army manoeuvres."

Hal G. Sours, Ohio Director of Highways, was re-elected president of the Association and Charles M. Upham was continued as engineer-director for 1941-1942. New officers are: D. A. McKinnon of Helena, Mont., vice-president, Western district; and directors, G. D. Kennedy, Michigan Commissioner of Highways; C. H. Purcell, California State Highway Engineer, and E. L. Roettiger, Wisconsin State Highway Engineer. The new officers will be installed next May in Washington at the annual business meeting.

At a meeting of the manufacturers S. F. Beatty, president of the Austin-Western Road Machinery Co., was elected president of the Manufacturers' Division.

New York State Sewage Works Association

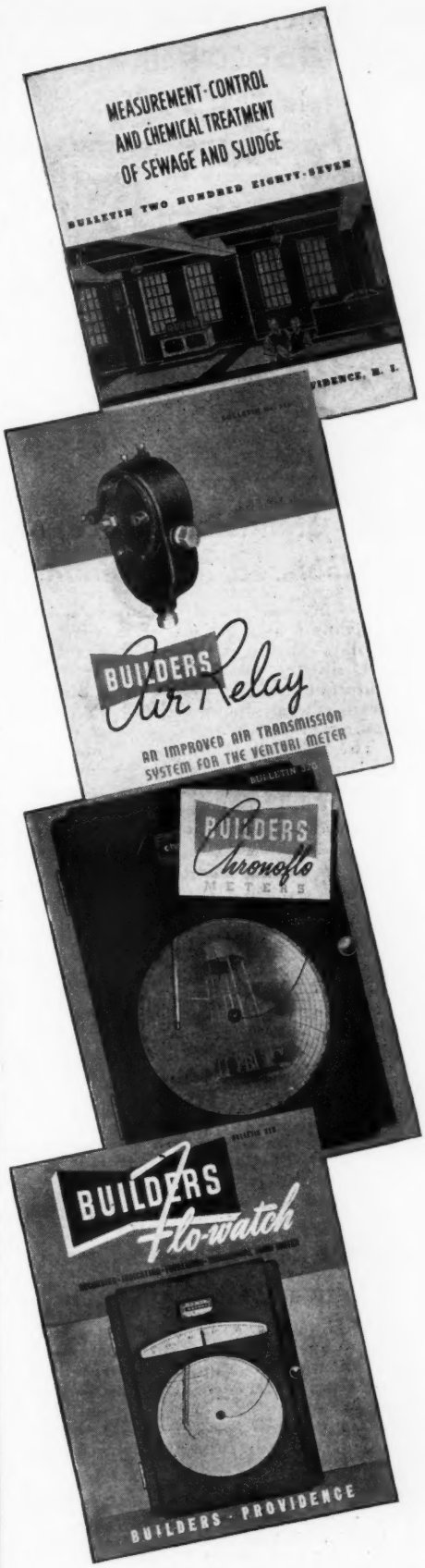
The Spring meeting of this association will be held in Niagara Falls on June 19-21, 1941. The Secretary is A. S. Bedell, State Dept. of Health, Albany, N. Y. The thirteenth annual meeting, held in New York City January 16-18, was attended by over 300 members and guests. At this meeting Prof. W. L. Malcolm, Chas. R. Velzy and Lawrence L. Luther were elected to the Executive Committee; Herbert H. Wagenhals was elected president and Robt. C. Wheeler vice-president.

American Public Health Assn. Announces Meeting

The seventieth annual meeting of this association will be held October 14-17, 1941, at Convention Hall, Atlantic City, N. J.; the residence headquarters being at the Totel Traymore. It is expected that more than 3,500 professional health workers will attend. Several related organizations will meet with this association, including the Conference of State Sanitary Engineers and the Conference of Municipal Public Health Engineers.

CHANGES IN PERSONNEL

Meredith Collier has been promoted to the position of Superintendent of Construction and Distribution of the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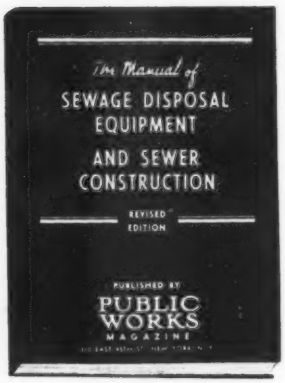

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Here in one handy volume is the equivalent of a whole filing case full of data—brief, unbiased descriptions and illustrations of every type of equipment and material available for use in sewage disposal, plus ads of the leading manufacturers.

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Book Dept., PUBLIC WORKS, 310 East 45th St., New York, N. Y. Enclosed is $1.50 for which send me one Manual of Sewage Disposal Equipment and Sewer Construction in accordance with your money-back-if-not-satisfied offer. 2-41

Name .....

Title .....

Street .....

City .....

Atlanta, Ga., water works, succeeding W. M. Rapp, deceased. Mr. Collier entered the employ of the water works in 1896 and has filled a number of positions, including machine shop mechanic, blacksmith and foreman of pipe line construction. For more than 25 years he has been engaged in waterworks engineering as assistant to Mr. Rapp.

The following new appointments as city engineers have been reported:

R. C. Lowrie, Pocatello, Idaho.
E. H. Brown, Seymour, Ind.
E. R. Bradley, Fleming, Ky.
George D. Henning, West Branch, Mich.
W. H. Carlson, West St. Paul, Minn.
H. O. Freeman, Trenton, Mo.
Clyde M. Pratt, Leonia, N. J.
D. Bennett Rasbach, Herkimer, N. Y.
John Joyce, Johnstown, N. Y.
Chas. Harmon, Norwood, Ohio.
Ralph Lee, Oklahoma City, Okla.
W. O. Washington, Brownsville, Tex.

The following City Manager has been appointed:

T. J. McCall, Plant City, Fla.

Water Works Superintendents recently appointed are:

Robert Coleman, Selma, Ala.
Steve J. Maciejewski, Calumet City, Ill.
Daniel Hanella, Elmwood Park, Ill.
Cleo Spry, Asst., Goshen, Ind.
Theodore E. Stimpson, Brunswick, Me.
Ellis Lunt, Newburyport, Mass.
G. Arthur Wells, Shrewsbury, Mass.
Chester Ostrowski, Hamtramck, Mich.
William E. Collings, Collingswood, N. J.
W. H. Graham, Verona, N. J.
Jay Ostrander, Canastota, N. Y.
Herbert Bachelder, Herkimer, N. Y.
H. T. Powell, Henderson, N. C.
Merle J. Miller, Bryan, Ohio.
Walter Waddell, Norwood, Ohio.
Joseph Vachon, Cumberland, R. I.
Frank E. Guhin, Aberdeen, S. D.
F. D. Yeary, Kingsville, Tex.

New County Engineers for 1941 include:

Elza G. Lenn, Warrick County, Boonville, Ind.
Maurice L. Scholl, Fayette County, Connersville, Ind.
Lowell B. Griffin, Johnson County, Franklin, Ind.
Virgil C. Ritter, Grant County, Marion, Ind.
J. T. McDonald, Henry County, New Castle, Ind.
D. R. Childress, Owen County, Spencer, Ind.
Carlton H. Vernon, Adams County, Corning, Iowa.
Forest W. Akers, Calhoun County, Rockwell City, Ia.
A. D. Finch, Fayette County, West Union, Ia.
M. M. Mayse, Clark County, Ashland, Kan.
Dale Rogers, Rawlins County, Atwood, Kan.
Ben W. Barber, Mitchell County, Beloit, Kan.
L. M. Gould, Coffey County, Burlington, Kan.
Clifford A. Palmquist, Cloud County, Concordia, Kan.
Edwin P. Knapp, Gove County, Gove, Kan.
Ralph E. Campbell, Graham County, Hill City, Kan.
Paul L. Millard, Jewell County, Mankato, Kan.
Max Engle, Jefferson County, Oskaloosa, Kan.
Walter W. Allen, Wallace County, Sharon Springs, Kan.
Rufus Kirk, Sumner County, Wellington, Kan.
William Cary Burns, Mercer County, Harrodsburg, Ky.
E. J. Allmendinger, Washtenaw County, Ann Arbor, Mich.
H. M. Griffith, Grand Traverse County, Traverse City, Mich.
George J. Matson, Redwood County, Acting, Redwood Falls, Minn.
Wm. N. Handley, Ray County, Richmond, Mo.
Jas. W Atkinson, Pettis County, Sedalia, Mo.
Carl Lemmer, Cascade County, Great Falls, Mont.
Robert W. Mann, Cass County, Plattsmouth, Nebr.
Jack E. Bogan, Seward County, Seward, Nebr.
Gerald J. Oram, Putnam County, Carmel, N. Y.
Charles H. O'Brien, Dutchess County, Poughkeepsie, N. Y.
Herrick Osborne, Warren County, Warrensburg, N. Y.
Thomas H. Murphy, Highland County, Hillsboro, Ohio.
Herbert Murmaugh, Allen County, Lima, Ohio.
Delos J. Nissen, Ottawa County, Port Clinton, Ohio.
G. W. Fling, Seneca County, Tiffin, Ohio.
Mayor Griswold, Champaign County, Urbana, Ohio.
Howard R. Craig, Auglaize County, Wapakoneta, Ohio.
Walter H. Metzler, Wayne County, Wooster, Ohio.
E. B. Ganham, Washington County, Bartletsville, Okla.
R. K. Caswell, Custer County, Clinton, Okla.
Paul N. Farrington, Payne County, Stillwater, Okla.
Wm. B. Gilbert, Deschuttes County, Bend, Ore.
Franklin E. Gilkey, Lincoln County, Toledo, Ore.
Lewis L. Gwin, Blair County, Altoona, Pa.
Madison H. Woodward, Greenville County, Greenville, S. C.
A. J. Caldwell, Spartanburg County, Spartanburg, S. C.
L. G. Larson, Clark County, Clark, S. D.
Elmer Mandrup, Charles Mix County, Lake Andes, S. D.
J. K. Black, Clay County, Vermillion, S. D.
Jas. D. Curnette, Nueces County, Corpus Christi, Tex.

Readers' Service Department

These booklets are FREE. Use the coupon below or write the manufacturer direct, mentioning PUBLIC WORKS.

Construction Materials and Equipment

Cold Mix Plants

10. New catalog and prices of Portable Bituminous Mixers in 6 to 14 ft. sizes for resurfacing and maintenance. Issued by The Jaeger Machine Co., 400 Dublin Ave., Columbus, Ohio.

Concrete Accelerators

30. "How to Cure Concrete," a forty-seven page manual published by the Dow Chemical Company, Midland, Michigan, treats fully subject suggested by title.

31. New 48-page booklet in five sections explains clearly the effects, advantages and methods of using Calcium Chloride and Portland Cement mixes. Complete and packed with practical information; well illustrated; pocket size. Sent free on request by Solvay Sales Corp., 40 Rector St., New York, N. Y.

33. Pocket manual of concrete curing with calcium chloride. Complete, handy. Contains useful tables, well illustrated. Write the Columbia Chemical Division, Pittsburgh Plate Glass Co., 30 Rockefeller Plaza, N. Y. C.

Concrete Mixers

44. Catalog and prices of Concrete Mixers, both Tilting and Non-Tilt types, from 3½S to 56S sizes. The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

Concreting in Winter

47. "Build Straight Through the Cold Weather Season" explains briefly how to obtain satisfactory winter concrete in less time. Write Michigan Alkali Co., 60 East 42nd St., New York, N. Y.

Drainage Products

70. Standard corrugated pipe, perforated pipe and MULTI PLATE pipe and arches — for culverts, sewers, subdrains, cattlepasses and other uses are described in a 48-page catalog entitled "ARMCO Drainage Products," issued by the Armco Drainage Products Association, Middletown, Ohio, and its associated member companies. Ask for Catalog No. 12.

71. Modern Culvert Practice — a 72 page book containing valuable data and tables will be sent promptly to anyone interested in drainage by Gohi Culvert Mfrs., Inc., Newport, Ky.

Generators

75. Homelite portable gasoline engine driven generators, both direct current and alternating current type, in sizes ranging from 500 watts output to 3,000 watts output, are fully described and illustrated in new folder. Homelite Corp., 2400 Riverdale Ave., Port Chester, N. Y.

Mud-Jack Method

107. How the Mud Jack Method for raising concrete curb, gutter, walls and street solves problems of that kind quickly and economically without the usual cost of time-consuming reconstruction activities — a new bulletin by Koehring Company, 3026 West Concordia Ave., Milwaukee, Wis.

Paving Materials, Bituminous

111. An excellent booklet issued by The Barrett Co., 40 Rector St., New York, N. Y., describes and illustrates the uses of each grade of Tarvia and Tarvialithic; 32 good illustrations.

Paving Materials, Brick

116. "New Developments in Brick Pavements." A review of the developments in brick pavements in recent years. Issued by the National Paving Brick Association, National Press Building, Washingon, D. C.

Pumps

121. New illustrated catalog and prices of Jaeger Sure Prime Pumps, 2" to 10" sizes, 7000 to 220,000 G.P.H. capacities, also Jetting, Caisson, Road Pumps, recently issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

123. New brochure by Gorman-Rupp Co., Mansfield, Ohio, illustrates and describes many of the pumps in their complete line. Covers heavy duty and standard duty self-priming centrifugals, jetting pumps, well point pumps, triplex road pumps and the lightweight pumps.

124. 16-page illustrated bulletin, SP-37, describes and illustrates complete C. H. & E. line of self-priming centrifugal pumps from ½" to 8", including lightweight models for easy portability. C. H. & E. Mfg. Co., 3841 No. Palmer St., Milwaukee, Wis.

125. Homelite portable self-priming centrifugal pump, gasoline driven, in sizes from 1½" to 4", fully described and illustrated in new folder. Homelite Corp., 2400 Riverdale Ave., Port Chester, N. Y.

Retaining Walls

126. Charts showing the design of cellular or bin-type metal retaining walls, helpful suggestions on their use for stabilizing slopes, preventing stream encroachment, and solving problems of limited right of way, and construction details are given in a 16-page bulletin entitled, "ARMCO Bin-Type Retaining Walls." It is published by the Armco Drainage Products Association, Middletown, Ohio, and member companies. Ask for Bulletin H-37.

Road Building and Maintenance

127. See road work as it was done in the 1890's and as it can be done by a full line of this year's road building equipment. See, in this new action picture book, the first reversible roller, 1893 World's Fair Award Grader and how methods have changed. Attractive new booklet AD-1796 recently issued by The Austin-Western Road Machinery Co., Aurora, Ill.

128. Motor Patrol Graders for road maintenance, road widening and road building, a complete line offering choice of weight, power, final drive and special equipment to exactly fit the job. Action pictures and full details are in catalogs Nos. 253, 254 & 255, issued by Galion Iron Works & Mfg. Co., Galion, Ohio.

129. New bulletins illustrate and describe the latest line of Littleford Utility Spray Tanks, Street Marking Units, Street Flushers and Kettles. Littleford Bros., 452 East Pearl St., Cincinnati, Ohio.

Rollers

133. New Tu-Ton roller of simple construction for use in rolling sidewalks along highways, playgrounds and other types of light rolling is fully described in a bulletin issued by C. H. & E. Mfg. Co., 3841 No. Palmer St., Milwaukee, Wis.

137. New bulletins describing in detail the new Huber Road Rollers and Huber Maintainers will be sent promptly on request from The Huber Mfg. Co., Marion, O.

138. "The Buffalo-Springfield line of road rollers (tandem, 3-wheel, and 3-axle) are described in the latest catalog issued by the Buffalo-Springfield Roller Co., Springfield, Ohio."

139. "Ironeroller" 3 Axle Roller for extra smooth surfaces on all bituminous work. Booklet contains roller data and operation details. Hercules Co., Marion, Ohio.

Spreader

147. Jaeger Paving equipment, including Mix-in-Place Roadbuilders, Bituminous Pavers, Concrete Bituminous Finishers, Adjustable Spreaders, Forms, etc.— 4 complete catalogs of latest equipment in one cover, issued by The Jaeger Machine Company, 400 Dublin Ave., Columbus, Ohio.

Soil Stabilization

150. "High-Service, Low Cost Roads" is one of the newer booklets using an effective combination of picture and text to set forth the principals and advantages of road surface stabilization with calcium chloride. Complete, interesting and well illustrated. 34 pages. Sent by Solvay Sales Corp., 40 Rector St., New York, N. Y.

152. The Columbia Alkali Corporation, will be glad to furnish to anyone interested complete information dealing with Calcium Chloride Stabilized Roads. This literature contains many charts, tables and useful information and can be obtained by writing Columbia Alkali Div., Pittsburgh Plate Glass Co., 30 Rockefeller Plaza, New York City.

153. "Rock Salt for Stabilized Roads" is a handy, illustrated booklet telling how to construct and maintain salt-soil-stabilized roads. Sent on request by International Salt Co., Scranton, Pa.

154. "Soil Stabilization with Tarvia" —An illustrated booklet describing The steps in the stabilization of roadway soil with Tarvia will be mailed on request by The Barrett Company, 40 Rector St., New York, N. Y.

Steel Forms

156. Complimentary Bulletin A-20-F, issued by The Heltzel Steel Form and Iron Co., Warren, Ohio, contains complete information on the use of steel forms for constructing concrete curbs, curb and gutters and sidewalks.

Tire Data

158. Handy pocket-size Goodyear Truck Tire Data Book contains load and inflation tables, dimenson data, factors governing mileage, for all types and sizes of truck, earthmoving and road grader tires. Also tables of weights and measures. Write Truck and Tractor Tire Div., Goodyear Tire & Rubber Co., Akron, O.

Tractors

159. "International Diesel TracTracTors" is a 48-page catalog giving full details of TracTracTors, including action pictures with bulldozers, bullgraders, blade graders, wheel scrapers, elevating graders, etc. Sent promptly by International Harvester Co., 180 North Michigan Ave., Chicago, Ill.

Street and Paving Maintenance

Asphalt Heaters

198. Illustrated Bulletins 15 to 20 describe Mohawk Oil Burning Torches; "Hot-

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2-41

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Readers' Service Department

(Continued from page 55)

stuf" Tar and Asphalt Heaters; Portable Trailer Tool Boxes; Pouring Pots and other equipment for street and highway maintenance, roofing, pipe coating, water proofing, etc. Mohawk Asphalt Heater Co., Frankfort, N. Y.

199. Aeroil "Heet-Masters" for quick heating and melting of tar, pitch, asphalt, etc., with less fuel are illustrated and explained in new catalog No. 196W issued by Aeroil Burner Co., Inc. Box 599, West New York, N. J.

Dust Control

210. "How to Maintain Roads with Dowflake" is a new 58 page illustrated booklet of information on stabilized road construction. Includes specifications and several pages of reference tables from an engineer's notebook. Issued by Dow Chemical Co., Midland, Mich.

211. A complete booklet on dust control titled. "Dust Control and Road Stabilization," describes the use of Columbia Calcium Chloride for dust control purposes and stabilization of roads. Sent on request by Columbia Alkali Div., Pittsburgh Plate Glass Co., 30 Rockefeller Plaza, New York, N. Y.

212. "Are you Annoyed by Dust?" an illustrated circular telling how to prevent dust with calcium chloride. Sent free by Michigan Alkali Co., 60 East 42 St., New York, N. Y.

Sprayers

280. Cutback sprayers with new "single unit safety control" and full control of all spraying operations from the nozzle are described and illustrated in new bulletin No. 190 W issued by Aeroil Burner Co., Box 599, West New York, N. J.

Street Markers

300. Street marking simplified by the use of modern, self-contained units capable of handling any kind of striping jobs is the subject of an illustrated bulletin giving also full details of new M-B Street Markers. Sent by Meili-Blumberg Corp., Box PW, New Holstein, Wis.

Snow Fighting

Plows

349. "V-type Plows for Motor Trucks" is a handsome new 24 page catalog illustrating the wide variety of models and many special features of Frink Sno-Plows and leveling wings. Tells how to select the proper plow for your trucks. Write Carl H. Frink, Mfr., Clayton, N. Y.

350. "Frink One-Way Sno-Plows" is a four page catalog illustrating and describing 5 models of One-Way Blade Type Sno-Plows for motor trucks from 1½ up to 8 tons capacity. Interchangeable with V Sno-Plow. Features, specifications and method of attaching. Carl H. Frink, Mfr., Clayton, 1000 Islands, N. Y.

Ice Control

351. "Make Icy Highways Safe for Traffic"—a new bulletin by Michigan Alkali Co., 60 East 42 St., New York, N. Y., tells how to use calcium chloride for modern ice control.

352. "Rock Salt's 'Auger Action' makes it most effective for removing ice from roads and streets" is a new illustrated folder just issued by International Salt Co., Scranton, Pa.

Sanitary Engineering

Aero-Filter

356. New illustrated bulletin gives complete information on design of Aero-Filters to provide high-capacity, uniform, raindrop application over the entire filter bed. Write Lakeside Engineering Corp., 222 West Adams St., Chicago, Ill.

Analysis of Water

360. "Methods of Analyzing Water for Municipal and Industrial Use" is an excellent 94 page booklet with many useful tables and formulas. Sent on request by Solvay Sales Corp., 40 Rector St., New York, N. Y.

Activation and Aeration

376. A valuable booklet on porous diffuser plates and tubes for sewage treatment plants. Covers permeability, porosity, pore size and pressure loss data, with curves. Also information on installations, with sketches and pictures, specifications, methods of cleaning and studies in permeability. 20pp. illustrated. Sent on request to Norton Company, Worcester, Mass.

Cleaning Sewers

383. A 20-page booklet describes and illustrates a full line of sewer cleaning equipment—Rods, Root Cutters, Buckets, Nozzles and Flushers. Write W. H. Stewart (Pioneer Mfr. since 1901), Jacksonville, Fla., or P. O. Box 767, Syracuse, N. Y.

Diesel Engines

386. Write Dept. 118, Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago, Ill., for data on how the installation of F-M diesels has lowered taxes and made it possible for many communities to pay for their improvements out of municipal power plant earnings.

Feeders, Chlorine, Amonia and Chemical

387. For chlorinating water supplies, sewage plants, swimming pools and feeding practically any chemical used in sanitation treatment of water and sewage. Flow of water controls dosage of chemical; reagent feed is immediately adjustable. Starts and stops automatically. Literature from % Proportioneers, Inc. % 96 Codding St., Providence, R. I.

Filter Plant Controllers

389. "The Modern Filter Plant" and the uses of Simplex Controllers for operation are described in a handy, 16-page booklet. Charts, data, curves and tables. Simplex Valve and Meter Co., 6750 Upland St., Philadelphia, Pa.

Fire Hydrants

390. Specifications for standard AWWA fire hydrants with helpful instructions for ordering, installing, repairing, lengthening and using. Issued by M. & H. Valve & Fittings Co., Anniston, Ala.

391. See listing No. 410.

Flow Meters

393. The primary devices for flow measurement—the orifice, the pilot tube, the venturi meter and others — and the application to them of the Simplex meter are described in a useful 24-page booklet (42A). Simplex Valve and Meter Co., 6750

Gates, Valves, Hydrants

394. Gate, flap and check valves; floor stands and fittings. New catalog No. 34 gives detail information with dimensions for all types of new full line. M. & H. Valve & Fittings Co., Anniston, Ala.

395. Complete booklet with much worthwhile water works data describes fully Ludlow hydrants and valves. Sent on request. Ludlow Valve Mfg. Co., Troy, N. Y.

396. See listing No. 410.

Hypochlorinators

400. New illustrated booklet **W&T** 357 describes this simple, inexpensive means of protecting small water supplies such as summer camps, hotels, swimming pools, dairies, etc., as well as for feeding chemical solutions in the water works plant. Contains typical installation sketches. Write "Wallace & Tiernan Co., Inc., Newark, N. J.

Manhole Covers and Inlets

402. Street, sewer and water castings in various styles, sizes and weights. Manhole covers, water meter covers, adjustable curb inlets, gutter crossing plates, valve and lamphole covers, ventilators, etc. Described in catalog issued by South Bend Foundry Co., Lafayette Boul. and Indiana Ave., South Bend, Ind.

Manhole Cover Silencers

403. New bulletin on Tapax for quickly ending noisy manhole covers and small sample free. Write Tapax Mfg. Co., 201 Hoyt Ave., Mamaroneck, N. Y.

Meters, Venturi

405. MS Meters for use with venturi tubes, flow nozzles, etc., in wall, panel, or floor mounting are covered in detail in catalog sent free by Simplex Valve & Meter Co., 6750 Upland St., Philadelphia, Pa.

406. New bulletin illustrates Builders Air Relay system of transmission for the Venturi Meter which is particularly useful for liquids containing suspended solids like sewage. Eliminates corroson, clogged pipes, etc. Write Builders Iron Foundry, Codding St., Providence, R. I.

Meters, Water

407. Complimentary bulletin W529 tells all about Pittsburgh IMO water meters, "the meters that wear in where others wear out." Write Pittsburgh Equitable Meter Co., Pittsburgh, Pa.

Pipe, Cast Iron

409. Cast iron pipe and fittings for water, gas, sewer and industrial service. Super-deLavaud centrifugally-cast and pit-cast pipe. Bell-and-spigot, U. S. Joint, flanged or flexible joints can be furnished to suit requirements. Write U. S. Pipe and Foundry Co., Burlington, N. J.

410. "Cast Iron Pipe and Fittings" is a well illustrated 44 page catalog giving full specifications for their complete line of Sand Spun Centrifugal Pipe, Fire Hydrants, Gate Valves, Special Castings, etc. Will be sent promptly by R. D. Wood Co., 400 Chestnut St., Philadelphia, Pa.

Pipe Forms

411. Making concrete pipe on the job to give employment at home is the subject of a new booklet just issued by Quinn Wire and Iron Works, 1621 Twelfth St., Boone, Ia., manufacturers of "Heavy Duty" Pipe Forms. Sent promptly on request.

Pipe, Reinforced Concrete

412. Literature describing the manufacture and installaton of Lock Joint Reinforced Concrete Pressure Pipe for water supply lines and sewer force mains. Lock Joint Pipe Co., Ampere, N. J.

Pipe, Transite

413. Two new illustrated booklets, "Tansite Pressure Pipe" and "Transite Sewer Pipe" deal with methods of cutting costs of installation and maintenance of pipe lines and summarize advantages resulting from use of Transite pipes. Sent promptly by Johns-Manville Corp., 22 East 40th St., New York, N. Y.

Pipe Joints, Sewer

415. How to make a perfect sewer pipe joint—tight, prevents roots entering sewer, keeps lengths perfectly aligned; can be laid with water in trench or pipe. General instructions issued by L. A. Weston, Adams, Mass.

Pumps and Well Water Systems

420. Installation views and sectional scenes on Layne Vertical Centrifugal and Vertical Turbine Pumps fully illustrated and including useful engineering data section. Layne Shutter Screens for Gravel Wall Wells. Write for descriptive booklets. Advertising Dept., Layne & Bowler, Inc., Box 186, Hollywood Station, Memphis, Tenn.

Meter Setting and Testing

430. The most complete catalog we have seen on setting and testing equipment for water meters—exquisitely printed and illustrated 48-page booklet you should have a copy of. Ask Ford Meter Box Co., Wabash, Ind.

Sand Expansion Indicator

432. New bulletin gives full details of Simplex Sand Expansion Indicators for water plants. Write Simplex Valve & Meter Co., 6750 Upland St., Philadelphia, Pa.

434. Be assured of uninterrupted, constant automatic removal of screenings. Folder 1587 tells how. Gives some of the outstanding advantages of "Straightline Bar Screens" (Vertical and Inclined types). Link-Belt Co., 307 N. Michigan Ave., Chicago, Ill.

436. "ARMCO Sewers" is the title of a 48-page booklet describing the structural and other advantages of ARMCO Ingot Iron. Paved Invert and Asbestos-Bonded pipe for storm and sanitary sewers. Design data and large charts will be found helpful by engineers engaged in the design or construction of sewers. Copies will be sent on request by the Armco Drainage Products Association, Middletown, Ohio, or its associated member companies.

Septic Tanks, Small

438. Septic Disposal Systems, Waterless Toilets, Multiple Toilets for Camps and Resorts, and other products for providing safer sewage disposal for unsewered areas are described and illustrated in data sheets issued by San-Equip Inc., 504 E. Glen St., Syracuse, N. Y.

Sludge Drying and Incineration

440. "Disposal of Municipal Refuse." Complete specifications and description including suggested form of proposal; form of guarantees; statements and approval sheet for comparing bids with diagramatic outline of various plant designs. 48 pages. Address: Morse Boulger Destructor Co., 216-P East 45th St., New York, N. Y.

441. Full information about Nichols modern, efficient gabage and refuse incinerators now available in the Basket Grate, Continuous Grate, Revolving Grate and Monohearth types will be sent promptly by Nichols Engineering and Research Corp., 60 Wall Tower, New York, N. Y.

442. Recuperator tubes made from Silicon Carbide and "Fireclay" Corebusters for maximum efficiency are described and illustrated in bulletin No. 11 issued by Fitch Recuperator Co., Plainfield National Bank Bldg., Plainfield, N. J.

443. Nichols Herreshoff incinerator for complete disposal of sewage solids and industrial wastes — a new booklet illustrates and explains how this Nichols incinerator works. Pictures recent installations. Write Nichols Engineering and Research Corp., 60 Wall Tower, New York, N. Y.

Swimming Pools

446. Data and complete information on swimming pool filters and recirculation plants; also on water filters and filtration equipment. For data prices, plans, etc., write Roberts Filter Mfg. Co., 640 Columbia Ave., Darby, Pa.

447. 40-page Manual on swimming pools. Includes swimming and pool layouts, specifications, etc., and details concerning Permutit Swimming Pool Equipment. Write The Permutit Co., Dept. G-4, 330 West 42 St., New York, N. Y.

Taste and Odor Control

450. Technical pub. No. 207 issued by Wallace & Tiernan Co., Inc., Newark, N. J., describes in detail taste and odor control of water with BREAK-POINT Chlorination, a method of discovering the point at which many causes of taste may be removed by chlorination with little or no increase in residual chlorine. Sent free to any operator requesting it.

Treatment

453. "Safe Sanitation for a Nation," an interesting booklet containing thumbnail descriptions of the different pieces of P.F.T. equipment for sewage treatment. Includes photos of various installations and complete list of literature available from this company. Write Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago, Ill.

455. New booklet (No. 1642 on Link-Belt Circuline Collectors for Settling Tanks contains excellent pictures; drawings of installations, sanitary engineering data and design details. Link-Belt Company, 2045 W. Hunting Park Ave., Philadelphia.

456. New 16-page illustrated catalog No. 1742 on Straightline Collectors for the efficient, continuous removal of sludge from rectangular tanks at sewarage and water plants. Contains layout drawings, installation pictures, and capacity tables. Address Link-Belt Co., 2045 West Hunting Park Ave., Philadelphia, Pa.

457. New illustrated folder (1942) on Straightline apparatus for the removal and washing of grit and detritus from rectangular grit chambers. Address: Link-Belt Co., 2045 W. Hunting Park Ave., Philadelphia, Pa.

458. "Sedimentation with Dorr Clarifiers" is a complete 36-page illustrated catalog with useful design data. Ask The Dorr Company, 570 Lexington Ave., New York, N. Y.

459. A combination mechanical clarifier and mechanical digester, The Dorr Clarigester, is explained and illustrated in a bulletin issued by The Dorr Company, 570 Lexington Ave., New York, N. Y.

460. This new 145 page illustrated chemical products book contains 55 pages of Tables, Factors and valuable Reference Data. Issued by General Chemical Co., 40 Rector St., New York, N. Y.

461. Prefloculation without chemicals with the Dorrco Clarifloculator in a single structure is the subject of a new booklet issued by The Door Company, 570 Lexington Ave., New York, N. Y.

462. Dorrco Monorake for existing rectangular sedimentation tanks, open or closed, is described and illustrated in a new catalog sent on request. The Dorr Co., 570 Lexington Ave., New York, N. Y.

Valves (See Gates, Air Release, etc.)

Water Works Operating Practices

490. "Important Factors in Coagulation" is an excellent review with bibliography and outlines of latest work done in the field. Written by Burton W. Graham and sent free on request to Activated Alum Corp., Curtis Bay, Baltimore, Md.

491. "Soft Water for Your Community" tells by means of many interesting pictures and text the advantages of soft water to any community. Ask for a copy from The Permutit Co., Dept. G4, 330 West 42nd St., New York, N. Y.

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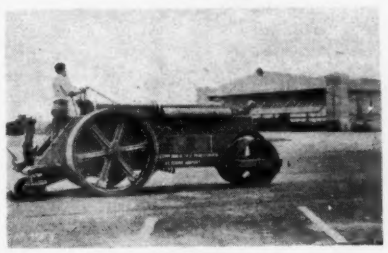

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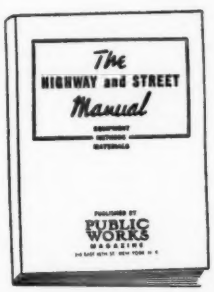

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Copies may be obtained without charge by writing to Solvay Sales Corporation, 40 Rector Street, New York, N. Y., and asking for the folder entitled, "Get These Nine Advantages in Winter Concreting by Using Solvay Calcium Chloride."

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